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THE GROWTH OF INTERNAL PASSENGER TRAFFIC IN NEW YORK was recently discussed before the Rapid Transit Commission, and the following figures were presented by Col. R. R. HAZARD in justification of the City Ry. Co.'s estimate of 75,000,000 passengers annually:

*New York City Passenger Traffic (thousands).*

| Year. | Pop. | N. and S. Surface lines. | Elevated lines. | E. & W. Surface lines. | Total movement. | Per c't increase. |
|---|---|---|---|---|---|---|
| 1875.... | 1,042 | 131,709 | 921 | 33,107 | 165,737 | .... |
| 1880.... | 1,206 | 105,203 | 60,832 | 43,411 | 209,446 | 26.3 |
| 1885.... | 1,439 | 142,038 | 103,355 | 48,276 | 293,669 | 40.2 |
| 1890.... | 1,710 | 162,244 | 185,834 | 56,320 | 404,398 | 37.8 |

It will be seen from this table that, while the population has increased about 64% in the past 15 years, the total passenger traffic has increased nearly 144%, or 2¼ times as rapidly, the rate of increase continuing to be about as the square of the population, as appears to be the rule in this and other cities.

OF THE ANTHRACITE COAL LANDS in the Schuylkill region in Pennsylvania, (which produces about one-third of the total anthracite output) 90% are owned by the Philadelphia & Reading Coal & Iron Co. The only remaining tract in that district of considerable importance, so situated that competitive transportation companies can reach it, has just been leased for 20 years by the Reading Co. The tract contains about 3,000 acres, and is estimated to contain 15,000,000 tons of coal, which is expected to be worked out before the contract expires. The owners of the lands agree to furnish at least 500,000 tons per annum for shipment. The first breaker and colliery, with a daily capacity of 1,000 tons, is completed, and a branch railway to reach the mines will be built from Mt. Carmel, Northumberland Co., at once.

THE NET EARNINGS OF 125 RAILWAYS for the month of January, 1891, according to statistics collected by the *Financial Chronicle*, amount to $13,972,540, against $12,464,056 for the corresponding month of 1890, an increase of 12.1 per cent. This showing appears upon its face very favorable, but an examination of the figures in detail detracts considerably from its favorable character. From these it is found that the three Pacific railways exhibit a gain aggregating $1,634,812 or $126,328 more than the gain by the entire 125 roads. Besides these there are three roads showing increases of over $125,000 each, and six roads showing increases of over $40,000 each. Seven roads show decreases of over $40,000 each, and an aggregate decrease of $947,725. Of these the C., B. & Q. heads the list with a decrease of $341,018 and is followed by the A., T. & S. F., the B. & O., and the Wabash, with decreases of $169,104, $121,834, and $121,111, respectively. The following table shows the earnings by groups for the two years of 1891 and 1890:

| | 1891. | 1890. | Inc. or Dec. P. c. |
|---|---|---|---|
| Trunk lines (11) | $5,521,327 | $3,652,404 | — 3.59 |
| Middle Western (22) | 935,651 | 952,164 | — 1.74 |
| Northwestern (12) | 1,526,205 | 1,766,242 | — 13.58 |
| Southwestern (6) | 851,627 | 1,032,024 | — 17.48 |
| Pacific roads (19) | 3,299,602 | 1,510,888 | + 118.3 |
| Southern (29) | 1,903,686 | 2,018,296 | — 1.22 |
| Coal roads (11) | 1,350,831 | 1,028,994 | + 31.28 |
| Eastern and Middle (14) | 405,981 | 420,026 | — 3.34 |
| Mexican (1) | 87,630 | 83,018 | — 5.56 |
| Total, 125 roads | $13,972,540 | $12,464,056 | + 12.10 |

A NOVEL ELECTRIC PLANT is being installed at Telluride, Colo., by the Gold King Milling & Mining Co. The gold ore at this place is abundant, but of such low grade that the operating expenses until recently were barely covered. The machinery was driven by steam engines, but fuel is now scarce, and the manager, Mr. L. L. NUNN, recently decided to utilize the water power in the vicinity. A dam was built across the San Miguel River, which falls 500 ft. in less than a mile at this place, and from the headgate the water is taken through a 4,000-ft. pipe, gradually decreasing in diameter from 20 to 12 ins., to the power station, where it is delivered to two 6-ft. Pelton wheels. Westinghouse machinery is used, and the loss in transmission between generator and motor, over a 2½-mile circuit, is said to be barely 5%.

THE WEEMS ELECTRIC RAILWAY, described and illustrated in our issue of Sept. 14, 1889, was the subject of a paper read before a recent meeting of the American Institute of Electrical Engineers, by Mr. O. T. CROSBY, who has conducted quite elaborate experiments with the system. Plans for passenger trains running at 150 miles an hour have been prepared and are pronounced practicable by Prof. H. A. ROWLAND and Dr. DUNCAN of Johns Hopkins University. The motor car is to have a 7-ft. driving wheel base, with armatures on each of the 2 axles, and a pony truck, the whole weighing 18 tons. The total cost per mile of a double-track line 1,000 miles long, including conducting system, stations and rolling stock, is estimated at $66,000. This estimate is based on a train equipment of 100 passenger and 50 motor cars.

A TRIAL OF THE HARVEY ARMOR PLATE was held in Annapolis March 14. A 10-in. Schneider plate 6 × 8 ft., treated by the hardening process invented by Mr. H. A. HARVEY, was mounted on the same backing used for the compound plate at the trials described in our issue of Oct. 4, 1891. A 6-in. gun, 14 ft. 6 ins. long, was mounted at a distance of 263 ft. from the plate and was fired 6 times, with a muzzle velocity of 2,091 f. s. and 100 lb. Holtzer or Carpenter projectiles. At the close of the trial the plate showed several through cracks but no part had fallen from its place. Only one projectile, the fifth, actually entered the plate, and none of them flaked off the hardened surface as in the September trials of the Cammell compound plate.

A COMMISSIONER OF HIGHWAYS AND BRIDGES is proposed as a state official in Massachusetts, and a bill prepared by the League of American Wheelmen authorizing such an appointment has been submitted to the legislative Committee on Roads and Bridges. The commissioner is to be a civil engineer and to hold office for a term of three years. His salary is to be $3,000 per annum, and he may expend not more than $3,000 per annum in necessary expenses. An office is to be provided in the city of Boston. He is to have a general advisory oversight of roads and bridges, to make annual inspections, compile statistics, and make an annual report to the legislature. He may be consulted by public officials, and upon the representation of 10 inhabitants of any city or town that any bridge or road is in unsafe condition he is to at once examine the same and notify the aldermen or selectmen of its condition. Important legislation tending to favor better highways was also passed in New Jersey at the last session of the legislature, as we have previously noted.

THE BRITISH IRON AND STEEL INSTITUTE has sent some valuable presents to the Americans on whom devolved the chief responsibility for the entertainment of the members of the institution who visited this country last fall. Among those receiving such presents are WM. P. SHINN, Chairman of the Transportation Committee; CHAS. KIRCHHOFF, Secretary of the American Reception Committee; JAS. F. LEWIS, Chairman of the New York Local Committee and conductor of the northern excursion; and ROSSITER W. RAYMOND, Secretary of the American Institute of Mining Engineers.

PROPOSALS FOR STEEL ARMOR PLATES have been called for by the Navy Department. This is the first advertisement under the bill requiring all armor-plate and gun-forging contracts to be advertised. Up to the present time the Bethlehem Iron Co. alone possessed the requisite machinery for manufacturing such forgings. Now, however, Carnegie, Phipps & Co. are prepared to make both plates and gun forgings, and the Midvale Steel Works will also enter bids for the latter.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision on the Chicago & Northwestern Ry., near Racine, Wis., March 24. A passenger train ran into a heavy freight train of 64 cars, which should have been sidetracked, but had run past the switch. One man was killed, and 5 were injured, 2 of them seriously. A mail car, baggage car and 5 freight cars were destroyed by fire. In this and the other accidents noted below, with one exception, the cars were set on fire. Another serious accident was a derailment, March 17, on the Quincy, Omaha & Kansas City Ry., near Kirksville, Mo. A broken wheel on the front truck of the smoking car caused that car and the passenger car next to it to leave the track. The smoking car went down the bank, turning over in its descent, and the passenger car was thrown with its front end down the bank, all the passengers being thrown to that end. This car caught fire, but the flames were extinguished before any damage was done. One person was killed and nearly 20 were injured, some seriously. Another derailment occurred on the Louisville & Nashville R. R. at Louisville, Ky., March 21. The engine of a passenger train left the track at a switch to a sidetrack, and fell over on its side. The express and mail cars were wrecked, the smoker thrown across the track, and 2 passenger cars derailed and upset, only the 2 rear sleepers remaining on the track. The engineer was killed and the fireman injured, but none of the passengers were hurt, except by slight cuts and bruises. While a Pennsylvania R. R. freight train was being sidetracked at Conesville, O., March 23, a coupling parted and the rear portion was left on the main track. Before a flagman could be sent out the cars were run into by the limited mail. The engine and one mail car, the caboose and 6 freight cars were wrecked, and 2 employees were injured. The second section of a freight train on the New York & New England R. R. ran into the first section near Terryville, Conn., March 24, derailing several cars. The stove in the caboose set fire to that car, which was destroyed, together with 2 freight cars.

BRIDGE ACCIDENTS are reported as follows: 3 spans of the Maine Central R. R. bridge at Farmington, Me., and a railway bridge between Gloversville and Johnstown, N. Y., were carried away by floods March 23. The foundations of a new iron bridge on the Shore Line near Leetes Island, Conn., have settled slightly, so that trains were sent round by another route until repairs had been made. A foot bridge at Rome, Ill., gave way March 18 and 5 persons were killed.

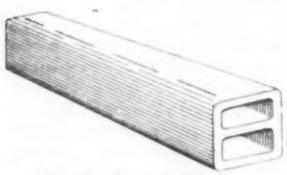
A LOCOMOTIVE BOILER explosion occurred on the Shenandoah Valley R. R., March 18, while the engine was hauling a train near Hollins, Va. The crown sheet collapsed, and the fireman was badly scalded. The engine was derailed.

A BREAK IN THE COFFER-DAM of the new canal at Sault Ste. Marie occurred March 18, and caused serious damage to the works. The break was closed with considerable difficulty.

## Underground Electric Conduits in Denver, Colo.

Some light is shed on the vexed question of the removal of wires and poles from the streets of our cities, as to which there is a sad lack of experimental knowledge, by some important and successful work of this kind lately done at Denver, Colo., of which the following brief but sufficiently detailed description has been sent us by Mr. A. McL. HAWKS:

The work was planned and carried out by the Colorado Telephone Co., under E. B. FIELD, General Manager, and W. S. FORD, Superintendent. It was decided more than a year ago by the city authorities to place some permanent pavement on the streets of the business portion of the city, and all water, gas and other interested companies were notified that pipes and subways must be placed before the commencement of such paving. The Telephone Co., realizing that they would soon be compelled by law to place their wires under ground, made a thorough investigation of all previous practice before making their decision. They finally decided upon a tile conduit of the pattern shown, which most closely resembles the Wilson, of Chicago, and the Lynch, of Washington. It is about 10 ins. square (with chamfered corners), 36 ins. in length and the walls 1 in. in thickness. The division wall makes two chambers about 3¼ × 8 ins., which dimensions were determined as being suited to contain three 100-pair wire cables. The length of 36 ins. is about the maximum at which clay tile can be manufactured for a reasonable cost; and was used to give a minimum number of joints, as these are always the weak points of the system. The first of these tiles were ordered from Ohio, but the cost of transportation was excessive, and as the clays near Golden, Col., were found to make as good or better tile, the remainder of the contract was given to parties there.



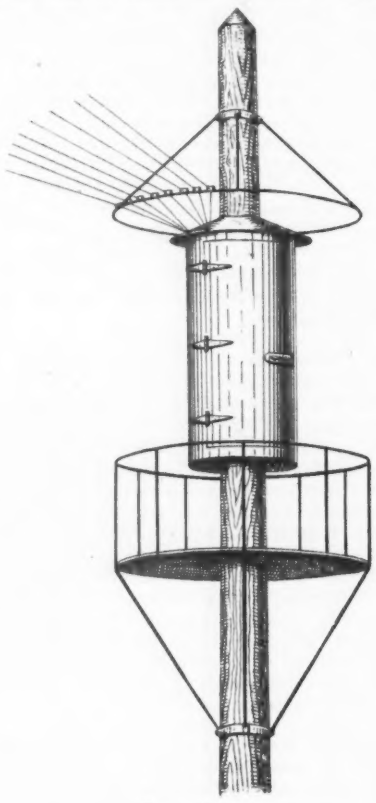
Tile for Electric Subway.

A careful study of the sub-surface conditions of the streets, the past growth of the city, the present locations of customers and the probable future location, led to the adoption of Fifteenth St. for the main stem, because on this street are the least number of underground pipes and conduits, the greatest distance from the steam-heating pipes (which have always caused great trouble to electric subways) can be obtained, and the greatest number of users easily reached. Facility of distribution and freedom from interference with all underground work led the alleys to be decided upon for all branches.

With these points determined, ground was broken in March, 1890, and the work vigorously pursued to a completion in September, during which time the main stem 5,478 ft. long, was trenched to an average width of 3.7 ft. and depth of 5.2 ft.; the branches, 14,377 ft. long were trenched to an average width of 2.7 ft. and depth of 5.0 ft.; the actual tile laid was 39,156 ft., which, as each foot of tile has a capacity of six 100-pair cables, is equal to 234,937 ft. of common duct. Add to this for spaces in manholes 5,353 ft., for 3-in. iron pipes used to pass boiler room vaults in the alleys 1,394 ft., and for iron terminals or thimbles, placed in manhole walls to stand the wear of drawing in the cables, 621 ft., and there is the grand total of 242,305 ft. of duct. Twenty main manholes from 5 to 7 ft. square, and averaging 8.7 ft. deep, and 65 branch manholes 4.5 ft. in diameter or 3 × 5.5 ft. oval, averaging 6 5 ft. deep, were built, and the numerous other details incident to a work of such magnitude were performed. The system is so arranged that it will accommodate 7,000 customers on a metallic circuit. As there are 2,000 now it allows of a great increase before any change need be made.

The tile were received at the yard and thoroughly inspected and tested by "ringing" with a blow of a hammer. They were then made up into 9 ft. lengths, as joints could be made better and more quickly than in the trench, in the following manner:

A large kettle was used, in which Trinidad asphalt was heated to about the boiling point. On opposite sides were 2 uprights terminating in journals, in which round iron rolls squared at the ends were placed. Strips of burlap 8 ins. wide and 200 ins. long (enough to make 5 complete wraps around the tile) were dipped into the asphalt and then wound on the roll, which 20 men carried to the joint to be made, unwinding the burlap on the tile and using the iron roll to pull the burlap tightly and to press it firmly against the tile in a manner somewhat similar to ironing clothes. As the asphalt is hot it penetrates the tile, making the burlap adhere and forms a water tight joint so strong that nothwithstanding the handling in carts and in the trench no leaks have yet occurred. To protect the cables from any water standing about them—which is always detrimental, if not positively injurious—all conduits have a grade towards a manhole, and the manholes themselves have drainage connections. The 9 ft. lengths were connected in the trench in a manner similar to the yard jointing, and manholes were built as the conduits reached them in order to avoid all sags or bends, and to make a straight



Sentry Box.

line, so that a light could be seen from each manhole into the next. The cables were drawn through the conduit by a rope and winch stationed at the adjacent manhole. Patterson 100-pair dry-core lead covered cable was adopted, and has proved thoroughly satisfactory in every respect. It weighs about 8 lbs. per ft., and, as the longest distance between two manholes, 480 ft., called for a 500 ft. length, weighing 4,000 lbs., it was no easy matter to handle it safely and draw it into the conduit without injury. After the cable was in the conduit a boat or form was drawn through to place it so that the next one could be easily drawn through.

For distribution a pole was erected in the alley near the center of the block and high enough to command all the surrounding buildings. The top is arranged in the manner shown in the illustration. A 3-in. iron pipe encasing the cable reaches from the alley manhole to about 7 ft. above the ground, and galvanized iron from there to the platform protects it from external injury. The cable ends in a terminal head in the sentry box, where wires are taken through openings in the box under the roof to the ring, and from there to the customer's building direct. This system greatly simplifies the wiring in the box and allows the platform to be placed from 10 to 20 ft. higher than on any cross-arm pole.

Part of the system has been in use nearly a year now, and the whole for about six months, with only two or three breaks. The success has been a surprise even to the promoters, and they are so well pleased with the results and so certain that they have hit on the right method that they will follow the same ideas in the area to be paved next year.

## An Automatic Regulator and Unloading Device for Air Compressors.

The Ingersoll-Sergeant Drill Co. has recently applied to its air compressors an ingenious device for automatically regulating the pressure in the receiver without stopping or slackening the speed of the compressor and without reference to the amount of air used. The device also serves to unload the engine. As can readily be seen, the amount of air consumed in a compressed air plant, especially where used chiefly for driving drills, is very variable. In a small plant it may often happen that all the drills will be stopped at the same time, when, of course, the pressure runs up very rapidly, even when the compressor is slowed to its lowest speed.

The device which we illustrate enables the compressor to run steadily along without regard to the stoppage of the drills, and the pressure of the air in the receiver is kept uniform.

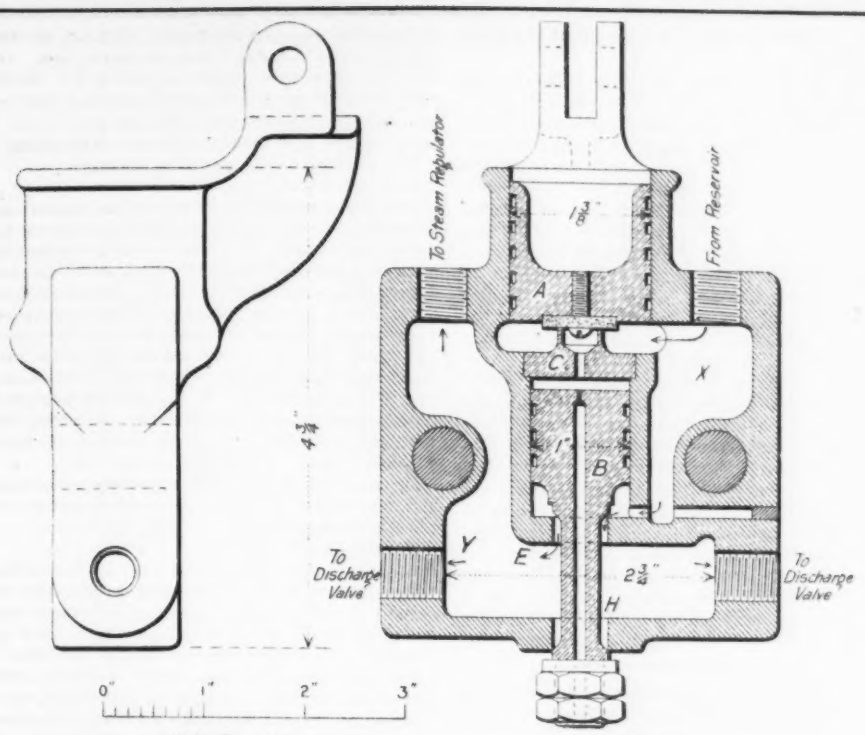
Fig. 1 shows a vertical section and side elevation of the regulator, which is seen to be a very small attachment, hardly as large as a good-sized oil-cup. It consists of two brass pistons *A* and *B*, working in a vertical cylinder, which has a fixed partition *C*, across it between the two pistons. The chamber *X* at the right of the cylinder is connected by a small pipe with the air receiver, and so is constantly filled with air at receiver pressure. The under side of the piston *A* is also exposed to the compressed air, being open to chamber *X*. It is kept down, however, by a weighted lever, similar to that on a safety valve. The fulcrum for this lever forms part of the regulator body as seen in the side elevation.

When the compressor is working under ordinary conditions the piston *B* is in the position shown in the drawing, and the chamber *Y* is also filled with compressed air, which passes from the chamber *X* through the orifice at its bottom and the opening around the rod of piston *B*, as shown by the arrows. The chamber *Y* is connected by small pipes with the steam regulator and with one discharge valve at each end of the air cylinder, as shown in Fig. 2.

Suppose now that, from any cause—as, for instance, the stoppage of the drills—the air pressure in the receiver rises to such a point that its pressure on the under side of piston *A* is greater than the pressure of the weighted lever above. Then piston *A* will move up a short distance until the lever brings up against a stop. This lifts the hard rubber valve on the under side of piston *A* from its seat, and the compressed air blows through the small orifice in the fixed partition *C*, and comes against the upper face of piston *B*. Evidently the area of this face is greater than the area of the lower face, and so piston *B* will be immediately forced down, closing the port *E* by which the compressed air is admitted to chamber *Y*, and opening the port *H*, leading to the outer air. As soon as this takes place the compressed air in chamber *Y* and in the pipes leading from it to the discharge valves, and the steam regulator blows out at the port *H*.

While the pipes *p*, *p* (see Fig. 2) were in communication with the receiver, as just explained, the pressure of the air continually tended to shut the discharge valves; but as soon as this compressed air in these pipes escapes, the pressure of the compressed air on the front of the valves forces them open and holds them open. This takes all load off the compressor; for instead of forcing air into the receiver, the piston only forces the air in the cylinder back and forth through the discharge pipe *D*.

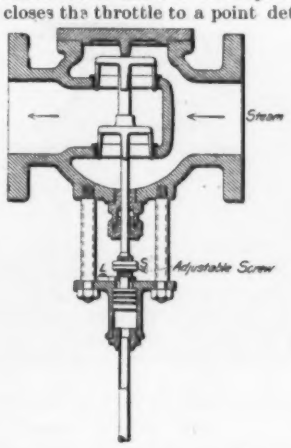
Evidently with the load thus taken off the compressor it would immediately run away if the steam were not turned off. This matter, however, is also taken care of by the regulator. In the main steam pipe is placed a throttle valve similiar to that on a locomotive, as shown in Fig. 2. It is slightly out of balance, so that the steam pressure constantly tends to shut it. To the stem of this valve is connected a small cylinder and piston, and the former is connected by a pipe with the chamber *Y* of the regulator. While this chamber is filled with compressed air, the pressure against the piston overbalances the pressure of the steam tending to close the throttle and keeps it wide open. As soon as the regulator




Side Elevation. Vertical Section.

FIG. 1. THE INGERSOLL SERGEANT DRILL COMPANY'S AUTOMATIC REGULATOR AND UNLOADING DEVICE FOR AIR COMPRESSORS.

valve opens, however, and the compressed air blows out of chamber *Y*, the pressure on the piston of the steam regulator ceases and the steam pressure immediately closes the throttle to a point determined by the adjustable stop *S*. This stop is adjusted to admit just enough steam to the compressor to overcome the friction and keep it moving at a moderate speed. One further necessary detail of the apparatus is a latch, *L*, which is always shut down before stopping the engine, and is not lifted after starting until the engine has been running long enough to accumulate pressure in the receiver sufficient to balance the steam pressure on the throttle.




Having seen how the regulator operates to unload the compressor and throttle the steam, let us see how it starts the machinery at work again when the pressure in the receiver falls. Referring again to Fig. 1 it will be seen that when this occurs the first movement will be the fall of the piston *A*, bringing the valve on its lower base down against its seat. This stops the flow of compressed air through the orifice in the partition *C*, and the pressure on the upper face of the piston *B* is quickly relieved through the small hole running through the piston rod to the open air. But the pressure of the compressed air on the lower face of piston *B* has continued constant, therefore the piston *B* lifts, shutting the port *H* and opening the port *E*. Through the latter the compressed air blows into chamber *Y*, filling it and its connecting pipes. The cylinder discharge valves are again placed in equilibrium and open and shut with the strokes of the piston, and at the same instant the throttle of the steam regulator is forced open, admitting the necessary steam to carry the load.

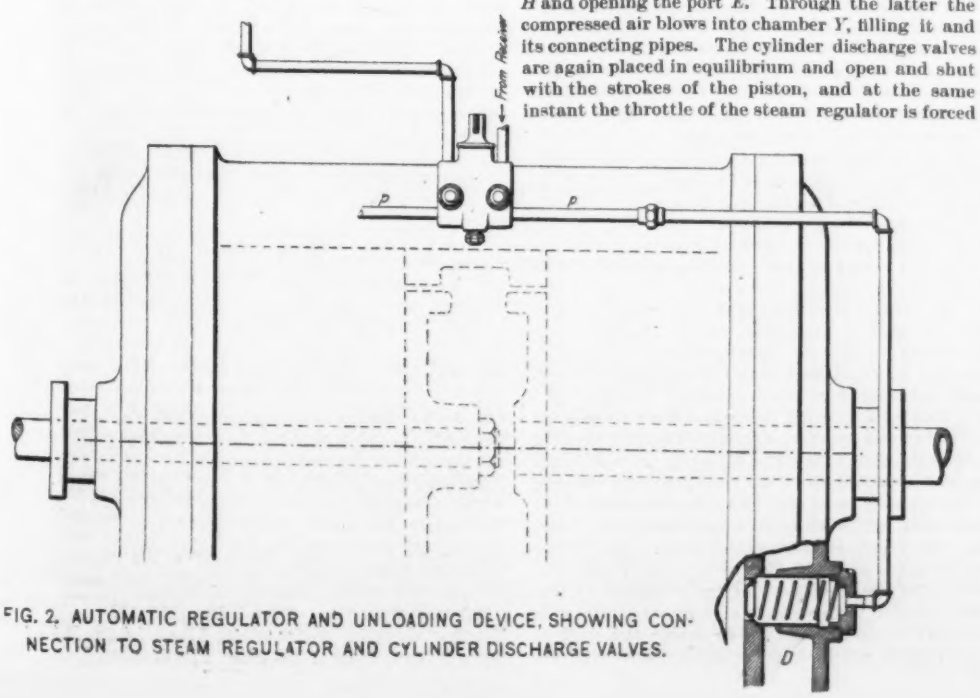



FIG. 2. AUTOMATIC REGULATOR AND UNLOADING DEVICE, SHOWING CONNECTION TO STEAM REGULATOR AND CYLINDER DISCHARGE VALVES.

An indicator card from the air cylinder when running with both discharge valves held open at a speed of about 100 revolutions per minute is shown in Fig. 3. A curious thing about the card is that the fall in pressure on the "suction" side of the piston is nearly twice as great as the increase in pressure on the forcing side. This is probably due to the design of the air passages through the discharge ports, which are, of course, made to facilitate the passage of the air outward from the cylinder.

The device may seem a little complicated at first sight, but its working is really very simple; and it

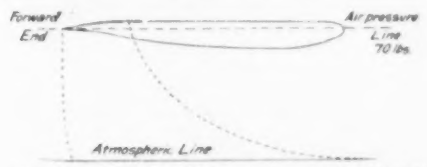



Fig. 3. Indicator Card from Unloaded Air Cylinder.

performs its duty with unfailing regularity, governing the movements of the largest compressors as easily as the smallest. With the ordinary method of throttling the steam and running the compressor at the lowest possible speed when the drills are all shut off, the compressor sometimes stops on its center and causes some trouble in starting up again. This device obviates all delays from this cause, and keeps the compressor running at steady speed and the receiver pressure uniform.

## High Explosives in Warfare.

A recent number of the *Journal of the Franklin Institute* contains an interesting lecture with the above title, delivered before the institute by Commander F. M. BARBER, U. S. N. The lecturer said that there are now over 350 different explosives manufactured, chiefly to meet commercial demands. In warfare, torpedoes were used by the Chinese many years ago, and in our Revolutionary war, but the first practical and successful application of them as recognized weapons was in the late civil war, when 37 vessels were either sunk or seriously injured by torpedoes charged with gunpowder.

For naval use, gun cotton and blasting gelatine are now generally employed, though there has been little experience with these in actual warfare. Two Peruvian vessels were sunk by dynamite in the Chili-Peruvian war; one Turkish by gun cotton in the Turco-Russian war of 1877, and two Chinese vessels by gun cotton in the Franco-Chinese war of 1884.

In comparing the relative strength of different explosives under water, curious and puzzling results have been obtained. The experiments of General ABBOT, at Willet's Point, in 1881, and those of Colonel BUCKNILL, Royal Engineers, of 1888, are given as follows; taking dynamite No. 1 as 100:

| | Gen. ABBOT. | Col. BUCKNILL. |
|---|---|---|
| Blasting gelatine | 142 | 142 |
| Forcite gelatine | 133 | 134 |
| Dynamite, No. 1 | 100 | 100 |
| Gun cotton, dry | ... | 80 |
| Gun cotton, wet | 87 | ... |
| Nitro-glycerine | 81 | 100 |
| Gunpowder | 20 to 50 | 25 |

Gen. ABBOT's experiments lead him to believe that an instantaneous mean pressure of 6,500 lbs. per sq. in. would give a fatal blow to the double bottom of a modern ironclad. Col. BUCKNILL figured that a pressure of 12,000 lbs. per sq. in. was needed. These two gentlemen have devised formulas for determining the quantity of blasting gelatine required to give this blow at various distances, with the following results:

| | Gen. ABBOT. | Col. BUCKNILL. |
|---|---|---|
| At 5 ft. | 4 lbs. | 23½ lbs. |
| " 10 " | 17 " | 75 " |
| " 20 " | 67 " | 177 " |
| " 30 " | 160 " | 274 " |
| " 40 " | 311 " | 369 " |

Commander BARBER discusses the relative action of gunpowder and detonating compounds, the first giving a push and the second a shock, and says that as the quantities increase the push reaches further than the shock. According to Gen. ABBOT, 100 lbs. of dynamite No. 1 will have a destructive horizontal range of 16.3 ft., while 100 lbs. of gunpowder will have a range of 3.3 ft. But 500 lbs. of dynamite will

have a range of 35 ft. and the same amount of gunpowder, 19¼ ft., thus diminishing the ratio with the quantity 5 to 2.

Omitting what relates to the varieties of torpedoes and their charges, and the conditions under which they will operate best, we can turn to the use of high explosives in shells, as one of the later points of experimental attack. For more than 30 years attention has been turned in this direction in Europe, but it is only lately that so-called satisfactory results have been reached, though reliable accounts are exceedingly difficult to obtain.

Dynamite in small quantities was fired in Sweden in 1867, and gun cotton in 1864 in France. But, in the latter case, if the shell cavity was filled the gun burst; and in the former case the quantity was so small that the effect was no greater than with gunpowder. While army men yet disagree as to the relative merits of breaking a shell into minute fragments by a high explosive, and into larger pieces with gunpowder, with a portion of the propulsive force imparted to these fragments, there is no question about modern armor-piercing shells. In the latter case the shell must be made of forged steel, so thick that the cavity for the bursting charge is reduced to one-fourth or one-fifth of what it was in the old form of shell. Here powder frequently fails to burst the shell at all, only blowing out the plug in the rear filling hole. The heat generated in passing through armor also, at times, prematurely ignites the powder.

The problem of filling this small cavity with an explosive that will not ignite prematurely and will yet burst the shell at the proper point is what military and navy men are now trying to solve. The Italians and Germans claim that they have accomplished this end up to 5 ins. thickness of armor, with gun cotton; the English deny this. The Austrians claim similar results with ecrastite (supposed to be blasting gelatine with sulphate or hydrochlorate of ammonia, and claimed to be 1½ times as powerful as dynamite). The Austrian accounts are also questioned. The French have tried melenite, which is said to be formed by the action of nitric acid upon phenol or phenyllic alcohol, a constituent of coal tar. Its present composition is not known, as it has been improved since its purchase by the French government from TURPIN, the inventor.

This melenite is nominally only three times as strong as gunpowder, but is said to owe its destructive quality in shells to the powerful character of the exploder used. A shell containing 119 lbs. of melenite will penetrate 10 ft. of solid cement; but will not penetrate 8 ins. of turret armor. It is claimed to be less dangerous than gun cotton to handle, and to be insensible to shock or friction, essential qualities in shell charges. Rumors concerning it, however, conflict.

At present the pneumatic gun is the prominent weapon in the field, though steam, carbonic acid gas, ammonia, etc., can be used as well as compressed air. With gunpowder, the pressure behind the projectile varies from 12 to 18 tons per sq. in., and this is as near as it can be regulated in the present stage of the manufacture of powder. The gun itself will endure a pressure of 25 to 30 tons; but when the shells carry a high explosive this powder pressure becomes a vitally serious matter. In the pneumatic gun the air pressure is maximum at 1,000 lbs. to the sq. in. and the barrel of the gun is long to take advantage of the expansion of the air.

Com. BARBER says that, up to the present time there have been no accidents in using most powerful explosives in their natural state and in quantities up to 50% of the weight of the projectile. A projectile weighing 950 lbs., carrying 300 lbs. of blasting gelatine and 200 lbs. of No. 1 dynamite, has been thrown nearly one mile and exploded after disappearing under the water. According to Gen. ABBOT'S formula such a charge would have sunk any iron-clad floating within 47 ft. of where it struck. The pneumatic gun has the advantage over mortar fire in the feature that the air pressure is under complete control, and at long or short range the fire is equally accurate. With the 15 in. pneumatic gun, with a pressure of 1,000 lbs., a velocity of about 800 f. s., and a range of 12,000 ft. has to be obtained, at an elevation of 30.20°; the projectile was about 8 calibres long and weighed 500 lbs., and would carry 220 lbs. of blasting gelatine. This was a sub-calibred projectile; with the full-sized improved projectile, weighing 1,000 lbs., a range of 7,500 ft. will doubtless be obtained.

Speaking of the effect of shells upon sandbag forts, Gen. GILLMORE is quoted as estimating that at Fort Wagner during our war, he threw one pound of metal for 3.27 lbs. of sand displaced. He fired 122,230 lbs. of metal, and one night's work would have repaired all the damage. A new 15-in. pneumatic shell, containing 600 lbs. of blasting gelatine would, according to German experiments at Kummsdorf, throw out either 500 lbs. or 2,000 lbs. of sand to one of shell, as the figures of Gen. ABBOT or Capt. ZELINSKI are used. The former considers that the radius of destructive effect increases as the square root of the charge; and the latter that this effect is directly proportionate to the charge.

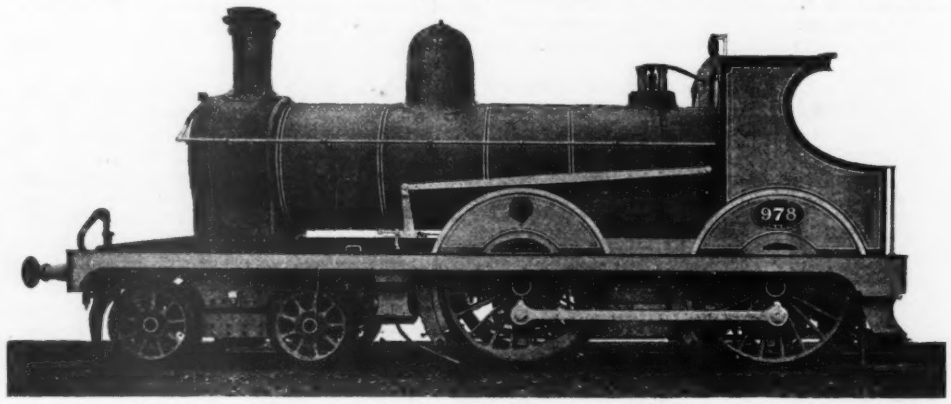
The effect of high explosives upon horizontal armor is very great; but we have yet to learn how to make it shatter vertical armor, and there is no satisfactory theory to account for this curious difference in effect. The French find that 4 ins. of vertical armor will keep out the largest melenite shells; and in experiments at Annapolis, in 1884, 75 to 100 lbs. of No 1 dynamite had no effect upon 12-in. iron plates bolted together when this target was vertical.

Commander BARBER, in closing, touched upon the possibilities of dynamite balloons, and automatic flying machines used for conveying the explosive over cities and dropping it by clock work apparatus.

## Express Passenger Locomotive; Lancashire & Yorkshire Railway, England.

(WITH INSET.)

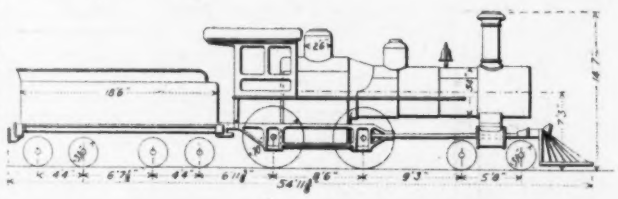
The engine of the Lancashire & Yorkshire Ry., which we illustrate this week, in connection with our description of the road in another article, is a good example of modern English locomotive practice, and is representative of a class of locomotives for passenger service which is in very extensive use on English railways, and which is coming more and more into use. This class is, in the arrangement of the wheels, similar to the American "eight-wheel" type, and is one of the standard types of passenger engines. Locomotives with a single pair of driving wheels of large diameter are also extensively used. In this country, however, with the increasing weight of trains, there is an increasing tendency toward the use of engines of the mogul and ten-wheel types for fast and heavy passenger trains. The main feature in which this class of engine differs from earlier English engines for the same service is the substitution of a four-wheel leading truck, or "bogie" (which was introduced on this line about 12 years ago), for a single leading axle. A very large number of engines with the single leading axle are in use, some of them with this axle carried rigidly in the frames, while others (as a step toward the truck) have the axle in radiating axle boxes. This latter arrangement does not always give satisfactory results. On the double-ended tank engines of this road, referred to in another column, the radial axle at each end has been applied to enable the engines to run either smokestack or bunker first, without having the increased weight of the truck, and the arrangement is said to give entire satisfaction. On other roads, however, tank engines with 4 coupled wheels, and a four-wheel leading or trailing truck, are extensively used and run either end first. Few, if any, engines now have two wheel or Bissell trucks.




EIGHT-WHEEL EXPRESS PASSENGER ENGINE; LANCASHIRE & YORKSHIRE RY., ENGLAND.

The driving wheels are 6 ft. diameter, which is rather below the average for English express engines, the sizes ranging from 6 ft. to 7 ft. 6 ins., or even 8 ft., the latter being generally for a single pair of driving wheels. In United States practice the range is generally from 5 ft. 8 ins. to 5 ft. 10 ins., larger wheels being exceptional. The New York, New Haven & Hartford R. R. had at one time some eight-wheel engines with 6 ft. driving wheels; but the wheels have been replaced by others 5 ft. 8 ins. diameter, which are said to prove more satisfactory. The Baltimore & Ohio R. R., however, has on its Washington express service some eight-wheel engines with cylinders 20 × 24 ins. and driving wheels 6 ft. 6 ins. diameter. The Pennsylvania R. R. has also eight-wheel engines with driving wheels of the same size, particulars of which are given in a foot note to the accompanying table.

The cylinders of the engine illustrated are 18 x 26 ins., and are placed inside the frames, with the slide valves placed on top of instead of between the cylinders. Some later engines of this class have cylinders 19 x 26 ins., and driving wheels 7 ft. 3 ins. diameter. The slide valve spindles are extended to have a bearing in the back end of the steam chest. The piston packing consists of 2 cast-iron rings. There are 4 slide bars on each side, with crosshead slides 13½ ins. long. The Joy valve gear is used, and is considered as good as the link gear. Screw reversing gear is used. The boiler is of ½-in. steel plates. The rivets are ⅛-in. diameter, and have a pitch of 1¾ ins. The rivet holes are drilled ⅜-in. diameter. The firebox shell is of steel and the roof stays are of cast steel. The firebox and tubes are of copper. The copper firebox stays are ⅜-in. diameter, with a pitch of 4 ins., and have 11 threads to the inch. The firebox and shell are flanged together at the fire door. The door is hinged at the top and swings inward, forming a deflector and a protection to the eyes of the men from the glare of the fire. The dome contains a throttle valve of the American double-seat or "double poppet type, which is worked from an eccentric on the valve rod. The safety valves are of the Ramsbottom duplex type generally used on English engines. The two valves are 3 ins. diameter, and the spring is set for them to blow off at a pressure of 160 lbs. per sq. in.



EIGHT-WHEEL ENGINE; SOUTHERN PACIFIC RY.

The main frames are of steel, 1 in. thick. The total length of the frame plates is 28 ft. 3 ins., and the distance between them is 4 ft. 2 ins. The distance from

COMPARATIVE DIMENSIONS OF ENGLISH AND AMERICAN PASSENGER LOCOMOTIVES.—EIGHT-WHEEL AMERICAN TYPE.

| | L. & Y. Ry. | B. & O. R. R. | N. Y. C. & H. R. R. R. | N. Y., L. E. & W. R. R. | O. C. R. R. | S. P. Ry. | N. Y., N. H. & H. R. R. |
|---|---|---|---|---|---|---|---|
| Cylinders | 18 × 26 ins. | 20 × 24 ins. | 19 × 24 ins. | 19 × 24 ins. | 18 × 24 ins. | 18 × 24 ins. | 17 × 22 ins. |
| Ports, length | ft. ins. 1 0⅛ | ft. ins. 1 6 | ft. ins. 1 6 | ft. ins. 1 6 | ft. ins. 1 6 | ft. ins. 1 4 | ft. ins. 1 2⅛ |
| Steam ports, width | 1⅝ | 1¼ | 1¼ | 1⅜ | 1¼ | 1⅝ | 1¼ |
| Exhaust ports, " | 3½ | 3 | 2¾ | 2¾ | 3 | 3 | 2½ |
| Dist. c. to c. of cylinders | 1 11 | 6 4 | 6 5 | 6 5 | 6 2 | ..... | 6 1 |
| Center line of cylinder to valve face | 1 0⅞ | 1 3¾ | 1 0⅝ | 1 6 | 1 2 | ..... | 10¾ |
| Slide valves, lap | 1 | 1 | 0⅞ | (out) $0^{15}/_{16}$ | 0⅞ | (in. 0; out, 0⅞ | $0^{13}/_{16}$ |
| " maximum travel | 4⅛ | 4¾ | 5½ | 6¼ | 5 | 5½ | 5 |
| " lead | $0^{2}/_{16}$ | $0^{1}/_{16}$ | $0^{1}/_{16}$ | 0⅛ | $0^{1}/_{32}$ | ..... | $0^{1}/_{16}$ |
| Piston rod, diameter | 3 | 3¼ | 3⅜ | 3¼ | 3⅜ | ..... | 3 |
| Wheels, coupled, diam. on tread | 6 0 | 5 8 | 5 10 | 5 8 | 5 9 | 5 10 | 5 8 |
| " truck, " " | 3 0½ | 2 6 | 2 6 | 2 9 | 2 6 | 2 9 | 2 6 |
| Wheel base, driving | 8 11 | 8 4 | 8 6 | 8 6 | 9 0 | 8 6 | 8 0 |
| " truck | 5 6 | 6 0 | 6 8 | 6 7 | 5 6 | 5 8 | 5 6 |
| " total | 21 10½ | 23 2 | 23 11 | 23 5¼ | 23 3½ | 23 5 | 21 9 |
| Dist. c. of truck pin to c. of driving axle | 10 2½ | 11 10 | 12 1 | 11 8 | 10 6½ | 12 1 | 10 11½ |
| Boiler, length of barrel | 10 8⅝ | 11 9 | 9 9 | 8 1⅝ | 11 2 | ..... | 16 5 |
| " diam. outside smallest ring | 4 2 | 4 6 | 4 10 | 4 8 | 4 5 | 4 6 | 4 0 |
| " thickness of plates | 0½ | 0½ | 0½ | 0½ | 0½ | $0^{7}/_{16}$ | 0⅝ |
| " " smoke-box tube plate | 0⅝ | 0½ | 0½ | 0½ | 0½ | ..... | 0½ |
| " height from rail to center line. | 7 3½ | 7 5 | 8 3½ | 7 5 | 6 11 | 7 3 | 6 2 |
| Fire-box shell, length outside | 6 0 | 10 $0^{13}/_{16}$ | 8 $8^{15}/_{16}$ | 12 4 | 7 $11^{13}/_{16}$ | ..... | 6 0 |
| " breadth outside at bottom | 4 1 | 2 $10^{5}/_{8}$ | 4 0 | 4 1¼ | 3 7⅛ | ..... | 3 5¾ |
| " depth c. line of boiler to bottom of mud ring | 5 1⅝ | 5 3 | 4 8 | 3 10¾ | 5 3 | 4 4 | 4 10 |
| " thickness of throat plate | 0⅝ | 0⅝ | 0⅝ | ..... | $0^{5}/_{16}$ | ..... | ..... |
| " " side plates | 0½ | $0^{5}/_{16}$ | 0½ | $0^{5}/_{16}$ | 0⅝ | ..... | $0^{5}/_{16}$ |
| " " top plates | 0½ | 0⅝ | 0½ | 0⅜ | 0⅝ | ..... | $0^{5}/_{16}$ |
| " " back plate | 0½ | $0^{5}/_{16}$ | 0½ | $0^{5}/_{16}$ | 0⅝ | ..... | $0^{5}/_{16}$ |
| Fire-box, length inside at bottom | 5 4⅝ | 10 0 | 8 0 | 11 $6^{7}/_{16}$ | 6 6 | 6 0 | 5 3 |
| " breadth " " | 3 6 | 2 10 | 3 4⅞ | 3 5⅝ | 2 $11^{5}/_{8}$ | 2 $10^{1}/_{2}$ | 2 $11^{3}/_{4}$ |
| " depth inside of crown to bottom of mud ring | 5 9⅝ | 6 3 | 5 10¼ | 5 0¼ | 6 3 | 6 4 | 5 8 |
| Fire box stays, diameter | ⅝ | 0⅝ | 1 | 0⅝ | 1" | ..... | $0^{15}/_{16}$ |
| " " pitch | 4 | 4 | 4¼ | 4¼ to 4½ in. | 4½ to the in. | ..... | ..... |
| Tubes, number | 220 | 194 | 268 | 246 | 221 | 232 | 174 |
| " diameter | 1¾ | 2¼ | 2 | 2 | 2 | 2 | 2 |
| " length between tube plates | 11 1½ | 11 6½ | 11 11 | 11 5 | 11 1¾ | 12 0 | 11 1 |
| Working pressure, lbs | 160 | 160 | 160 | 145 | 175 | ..... | 130 |
| Heating surface, tubes, sq. ft | 1,121.32 | 1,318.93 | 1,670.7 | 1,470.48 | 1,292 | 1,446.4 | 1,270.49 |
| " " fire box, " | 107.68 | 168.80 | 150.8 | 160.91 | 138 | 133.9 | 136.75 |
| " " total, " | 1,229.00 | 1,487.73 | 1,821.5 | 1,631.39 | 1,430 | 1,580.3 | 1,407.24 |
| Grate area, sq. ft | 18.75 | 28.33 | 27.3 | 40.0 | 19 | 17.3 | 22.53 |
| Weight in working order, total, lbs | 96,992 | 111,000 | 120,000 | 119,000 | 97,851 | 95,000 | 74,800 |
| " " on truck, lbs | 30,912 | 35,200 | 40,000 | 38,500 | 34,630 | 32,000 | 29,800 |
| " " on driving-wheels, lbs | 33,600 | 75,800 | 80,000 | 80,500 | 63,220 | 63,000 | 22,700 / 22,300 |
| " " on trailing-wheels, lbs | 32,480 | | | | | | |
| Weight empty, total, lbs | 89,600 | 99,025 | ..... | ..... | ..... | ..... | 66,900 |
| " on truck, lbs | 27,832 | ..... | ..... | ..... | ..... | ..... | 26,750 |
| " on driving wheels, lbs | 31,752 | ..... | ..... | ..... | ..... | ..... | 21,600 |
| " on trailing wheels lbs | 30,016 | ..... | ..... | ..... | ..... | ..... | 18,550 |
| *Tender:* | 6-wheel. | 8-wheel. | 8-wheel. | 8-wheel. | 8-wheel. | 8-wheel. | 8-wheel. |
| Diam. of wheels | ft. ins. 3 7⅝ | ft. ins. 2 6 | ft. ins. 2 6 | ft. ins. 3 0 | ft. ins. 3 2 | ft. ins. 2 9 | ft. ins. 2 6 |
| Dist. c. to c. of axles (L. & Y.) | 6 3 | ..... | ..... | ..... | ..... | ..... | ..... |
| Dist. c. to c. of truck pins | ..... | 12 0 | 10 9½ | 10 11 | 11 2 | 10 11½ | 9 10¾ |
| Wheel base | 12 6 | 17 0 | 15 2½ | 16 1 | 15 10 | 15 3½ | 14 9¾ |
| Capacity of tank (U. S. galls) | 2,400 | 3,500 | 3,587 | 3,600 | 3,600 | 3,600 | 3,200 |
| " coal space, lbs | 6,720 | 13,000 | 15,120 | 16,000 | 8,960 | ..... | 10,080 |
| Weight in working order, total, lbs | 61,488 | 77,200 | 80,000 | 65,500 | 66,500 | ..... | 61,300 |
| " on leading axle (L. & Y.) or truck, lbs | 21,280 | 38,600 | ..... | 30,500 | 32,500 | ..... | 28,950 |
| " on middle axle (L. & Y.), lbs | 19,712 | ..... | ..... | ..... | ..... | ..... | ..... |
| " on trailing axle (L. & Y.) or truck, lbs | 20,496 | 38,600 | ..... | 35,000 | 34,000 | ..... | 32,650 |
| Weight, empty, total, lbs | 37,408 | 35,640 | ..... | ..... | 49,700 | ..... | 32,300 |
| " on leading axle (L. & Y.) or truck, lbs | 13,552 | 17,820 | ..... | ..... | 24,600 | ..... | 14,850 |
| " on middle axle (L. & Y.), lbs | 12,656 | ..... | ..... | ..... | ..... | ..... | ..... |
| " on trailing axle (L. & Y.) or truck, lbs | 11,200 | 17,820 | ..... | ..... | 25,100 | ..... | 17,450 |

**Notes.**—*Baltimore & Ohio R. R.*—The boiler is made with butt joints, and has a total length of 25 ft. 0⅛ in. Height from rail to top of smokestack, 14 ft. 7¾ ins. Length of smoke-box, 33½ ins., and of extension front, 36 ins. Length of cab, 6 ft. 10 ins. Total length from nose of pilot to rear of frame, 34 ft. 7½ ins., and from nose of pilot to end of tender drawhead, 55 ft. 8 ins. Width over frames, 4 ft. 2 ins. Tubes spaced 2⅛ ins. Tractive force per pound of effective pressure per sq. in., 141.15 lbs. The first of these engines was built in December, 1890.

*New York, Lake Erie & Western R. R.*—Length of boiler, including smoke-box and extension front, 14 ft. 5¼ ins. Depth from c. line of boiler and from inside of fire-box crown to bottom of mud ring, respectively, 3 ft. 10¾ ins. and 5 ft. 0¼ in. at front, 3 ft. 1¾ ins. and 4 ft. 3¼ ins. at back. Lead of slide valve, ⅛-in. full stroke forward.

*Old Colony R. R.*—Length of boiler barrel out to out of tube sheets, 11 ft. 2¾ ins. Boiler holds 8,800 lbs. of water. Lead of slide valve, $\frac{1}{32}$ in. at full stroke. The weights on tender trucks are estimated.

*Southern Pacific Ry.*—Height from rail to top of smokestack, 14 ft. 7 ins. Crown bars, 5 × ¾ in., welded at ends. Journals: driving, 7½ × 8½ ins.; truck, 5 × 9 ins.; tender truck, 3¾ × 7 ins.; crank pin, 4½ × 4½ ins.; side rod, 3¼ × 3¼. Bridges between valve ports, 1⅝ ins. The truck is of the rigid center type. Total wheel base of engine and tender, 45 ft. 7¾ ins. Length from nose of pilot to end of tender drawhead, 54 ft. 11⅝ ins. Length of tender frame, 19 ft. 7¼ ins. Tender tank, 18 ft. 6 ins. long, 4 ft. high. Cab, 6 ft. 8 ins. long, 5 ft. 4 ins. high from running board. The engine will pass curves of 350 ft. radius. Weight of engine and tender in working order, with 5½ tons of coal on the tender, 183,680 lbs.

*Pennsylvania R. R.*—Since the above table was prepared we have received the following particulars of a class K anthracite burning locomotive of this road, which has been built about 10 years. The particulars are given in the order of the tabulated list. Cylinders, 18 × 24 ins.; ports, 1 ft. 4¾ ins. long; steam ports, 1¼ ins. wide; exhaust ports, 3¼ ins. wide; distance c. to c. of cylinders, 6 ft. 5 ins.; center line of cylinder to valve face, 1 ft. 4⅝ ins.; slide valves, 1¼ ins. outside lap, 5⅛ ins. maximum travel, 1-16-in. lead. Piston rod, 3 ins. diameter. Coupled wheels, 6 ft. 6 ins. diameter; truck wheels, 2 ft. 9 ins. diameter; driving-wheel base, 7 ft. 9 ins.; truck-wheel base, 6 ft. 7 ins.; total wheel base, 22 ft. 8 ins.; distance c. of truck pin to c. of driving axle, 11 ft. 8 ins. Boiler, 11 ft. 3⅝ ins. long from outside of throat-sheet to smokebox; 50 ins. diameter outside smallest ring; plates, ⅜ in. thick; smokebox tube-plate, ½-in. thick; height from rail to center line, 7 ft. 5¼ ins.; length of smokebox, 5 ft. 5⅜ ins. Firebox shell, 10 ft. 9¼ ins. long outside, 4 ft. 1⅝ ins. wide outside at bottom; depth below c. line of boiler to bottom of mud ring, 3 ft. 0¼ in. at back and 3 ft. 6⅛ ins. at front end; thickness of side plates, ¼-in.; thickness of top and back plates, $\frac{5}{16}$-in.; firebox staybolts, ⅜ in. diameter and 4 ins. pitch. Firebox, 9 ft. $11^{11}/_{16}$ ins. long inside at bottom, 3 ft. 5¾ ins. wide; depth from inside of crown to bottom of mud ring, 3 ft. $9^{15}/_{16}$ ins. Tubes, 201, 1⅝ ins. and 174 ins. and 17¼ ins. inside and outside diameter, 10 ft. $10^{13}/_{16}$ ins. long between tube-plates. Working pressure, 140 lbs. per sq in. Heating surface: tubes, 1,085 sq. ft. external; firebox, 155 sq. ft.; total, 1,240 sq. ft. Grate area, 34 8 sq. ft. Weight in working order: on truck, 31,800 lbs.; on driving wheels, 64,900 lbs.; total, 96,700 lbs. Weight empty: on truck, 29,300 lbs.; on driving wheels, 58,500 lbs; total, 87,800 lbs. Tender, 8 wheels, 2 ft. 9 in. diameter; distance, c. to c. of truck pins, 10 ft. 6 ins.; truck wheel base, 5 ft.; total wheel base, 15 ft. 6 ins. Capacity of tank, 2,400 galls.; capacity of coal space, 12,000 lbs. Weight: 56,300 lbs. in working order, 26,100 lbs. empty. The tender is fitted with a water scoop.

the center of the truck to the front buffer plate is 4 ft. 10½ ins., and from the center of the trailing axle to the rear end of the frames is 4 ft. 3 ins. The truck frames are of steel, ⅞-in. thick. They are 8 ft. 5 ins. long and 4 ft. 0¼ in. apart. The distance from the center of each truck axle to the ends of the truck frames is 1 ft. 5½ ins. The sandboxes are placed outside the main frames, being behind the step irons and below the running boards. The cab is roomy and of the ordinary modern English style, affording fairly good shelter, but not enough for bad weather. The Northeastern Ry. has some engines with cabs approximating to the American style, and the Great Eastern Ry. had some also, as shown on p. 242. Most of the English tank engines of modern construction have the foot-plate roofed in and inclosed, with an opening at each side, over the steps.

The wheels are of cast steel. The cranked driving axle has crank bearings 7½ ins. diameter and 4½ ins. long. The driving springs are hung under the axles. In some cases coiled springs are used, as shown on the inset sheet, but the later practice is to use elliptical laminated springs, as shown in the general view. Equalizing beams are not used, although very generally adopted on other English railways. The truck is of the swing link type. The weight of 30,912 lbs. on the truck is distributed as follows: 15,232 lbs. on the leading axle and 15,680 lbs. on the rear axle. The engine is fitted with the automatic vacuum train brake and vacuum driver brake. The driver brake shoes are on the leading side of the wheels. The brake cylinder is under the foot-plate. Lubrication of the 4 driving journals is provided for by an oil-box to each with 3 pipes to the bearings. The axles are all of steel, and are of the following dimensions:

| | Crank axle. ins. | Trailing axle. ins. | Truck axles. ins. |
|---|---|---|---|
| Diam. at wheel seat | 8⅝ | 8⅝ | 6¼ |
| " of bearings | 7½ | 7½ | 5½ |
| " at center | 7 | 6½ | 5¼ |
| Length of wheel seat | 7 | 7 | $6^{1}/_{16}$ |
| " bearings | 9 | 9 | 9½ |
| Dist. c. to c. of bearings | 45½ | 45½ | 43 |

The tender is of the ordinary English style, with 3 axles carried rigidly in the frames. It is smaller, and has a less capacity, than the average American tender. The Great North of Scotland Ry. has recently brought out some passenger engines with tenders carried on a four-wheel truck at the front end and 2 rigid axles. This is, however, one of the very few cases in which the truck has been applied to the tenders of English engines.

The weight of train hauled by these engines is about 200 tons, equivalent to 14 cars with 5 compartments each. In summer time the number of cars is frequently increased to 20 cars, or nearly 300 tons. The engines were designed by Mr. J. A. F. ASPINALL, M. Inst. C. E., the Chief Mechanical Engineer of the line, and were built at the company's new works at Horwich, which are described in another column.

The accompanying table gives the leading dimensions of the English engine, together with those of six engines of similar type on six American railways, as follows: Baltimore & Ohio R. R., New York Central & Hudson River R. R., New York, Lake Erie & Western R. R., New York, New Haven & Hartford R. R., Old Colony R. R., and Southern Pacific Ry. We give an outline diagram of the Southern Pacific engine, showing the general style of an American engine of the eight-wheel type. All of these engines have cylinders of shorter stroke than the English engine, and have smaller driving and truck wheels. The wheel bases are very nearly the same. The fire-boxes of the New York Central, Baltimore & Ohio and Erie engines are exceptionally long. The American engines have larger tubes than the English engine, thereby improving the steaming capacity of the boilers. The New Haven engine has a low boiler pressure of 130 lbs. per sq. in., while the Old Colony engine has 175 lbs., the Erie has 145 lbs. and the others 160 lbs. The English engine has the smallest heating surface and almost the smallest grate area. The Baltimore & Ohio, Erie and New York Central engines are the heaviest, the two latter having 80,500 and 80,000 lbs. respectively on the driving wheels.

Among detailed descriptions and illustrations of other English and American engines published in ENGINEERING NEWS, which may be convenient for comparison with the engines described in this article, may be mentioned the following: Georgia Pacific R. R., ten-wheel engine, April 5, 1890; Baltimore & Ohio R. R., eight-wheel engine, four-cylinder compound, May 3, 1890; Chicago, Burlington & Quincy R. R., mogul engine, June 28 and July 5, 1890; Canadian Pacific Ry., ten-wheel engine, Aug. 30, 1890. We have also published illustrated articles on English locomotives as follows: London & Southwestern Ry., eight-wheel engine, Nov. 25, 1887; London & Northwestern Ry., three-cylinder compound, Jan. 26, 1889; Southeastern Ry., eight-wheel, Feb. 22, 1890; Metropolitan District Ry., eight-wheel, March 22, 1890. A number of English locomotives of various classes are also illustrated in the series of articles on "English Railways" in the current volume.

## Brick Pavement in Columbus, O.

Columbus, O., says the *Commercial Gazette*, of Cincinnati, has a population of 90,000 and 60 miles of paved modern streets. At this time it has 12 miles of brick pavement. The first brick pavement was of the Hayden block type, laid down in June, 1885, and is still in good condition, practically as good as five years ago. The Hallwood block is also now used.

The Hayden block is 10 ins. long by 5 ins. in width and thickness, and it weighs 16¾ lbs. On the top surface are 18 indentations in three rows of six each. On the under surface are two holes extending half through the block, to secure thorough vitrification, and filled with wet sand or cement when laid, These blocks have been tested by lying in water for 24 days, with 2 to 3ozs. of absorption by being kept at zero to 10° for 24 days, and then being made red-hot and ice-water poured on them. They stood the latter test without cracking.

The Hallwood block is 9 ins. long by 4 ins. wide and 3 ins. deep, and weighs 9 lbs. This block has beveled edges and an intervening groove, into which hot pitch or cement is poured when laid. On East Broad St., paved with this block, there is a grade of 8%. In the tunnel under High St. there is a 12 to 14% grade, which is paved in part with Medina stone, and with occasional rows of Hallwood blocks. The Medina stone is worn to a considerable extent, and some should be renewed. The committee who investigated this matter says that the brick blocks show literally no signs of wear, though put down at the same time. The Ohio Paving Co., which makes these blocks, is said to have paved or contracted to pave 25 miles of streets, chiefly in Columbus and Chattanooga.

As to wearing qualities the following figures are quoted from tests made by the Canton Brick Co. of vitrified paving brick. The tests were made on 2-in. cubes, on an Olsen 50,000-lb. machine, at the Pittsburg Testing Laboratory. The five specimens of brick "spalled" at from 27,400 lbs. to 44,200 lbs., and, except No. 2, were not crushed. No. 2 cracked slightly at 36,700 lbs., but did not begin to spall until the load reached 42,200 lbs. A comparative test of similar granite cubes, made at Cincinnati, Aug. 7, 1886, showed cracking at 16,320 to 28,000 lbs., spalling at 17,370 to 22,000 lbs. and crushing at 17,500 to 30,100 lbs.

The City Engineer of Columbus gives the following table of cost of this brick pavement laid on broken stone or concrete foundations :

| | Per square yard. |
|---|---|
| Georgia granite block | $4.23 to $3.75 |
| Alderson Virginia block | 4.00 to 3.75 |
| First-class Medina block | 3.94 to 3.70 |
| Second-class Medina block | 3.19 to 2.98 |
| Greenfield block | 3.25 to 3.00 |
| Hayden block | 2.35 to 2.25 |
| Hallwood block | 2.35 to 2.20 |
| Asphalt 4-in. concrete foundation | 2.40 to 2.00 |
| Asphalt 6-in. concrete foundation | 3.00 to 2.75 |
| Wassall fire-clay brick | 2 00 to 1.95 |
| West Virginia fire-clay brick | 1.90 to 1.85 |
| Terra cotta fire clay brick | 2.25 to 2.22 |
| Zanesville red brick | 1.85 to 1.75 |
| Cleveland red brick | 2.00 to 1.90 |
| Middleport red brick | 2.00 to 1.80 |
| Red brick on board foundation | 2.00 to 1.75 |

## River Pollution in the United States.*

(*Concluded from page* 284.)

The Blackstone River is of a different nature. It is a small river and receives a large amount of pollution early in its course from the sewage of the city of Worcester and the refuse liquors from wire works and similar establishments. The amount of pollution it receives below this point is relatively small, while the amount of water it receives from unpolluted sources is comparatively large. We should therefore expect a reduction in the relative amount of pollution in the river, and the expectation is realized.

Results of chemical examinations are given in the reports for 1874 and 1876 and a statement of the observed sources of pollution of particular importance is given in that for 1876. The following table is abstracted from the table of results in the report for 1888 and gives the means of the results there given. All results show the same thing, and these are taken because they are in the most convenient form. The mean is of six or seven results in each case. The location of the examinations is as follows:

1. Leicester storage reservoir, above the city.
2. Worcester, one mile below outlet of Worcester sewer; about 75 square miles of water-shed.
3. Uxbridge, after dilution of Lake Quinsigamond and other tributaries, total water-shed above this point about 150 square miles.
4. Millville, near the Rhode Island boundary, total water-shed above this point about 276 square miles.

| No. | Free ammonia. | Albuminoid ammonia. | Nitrogen as nitrates. |
|---|---|---|---|
| 1 | 0 0057 | 0.0194 | 0.004 |
| 2 | 0.2471 | 0.1578 | 0.018 |
| 3 | 0.1148 | 0.0430 | 0.034 |
| 4 | 0.0492 | 0.0233 | 0 021 |

| No. | Total solids. | Loss on ignition. | Fixed solids. | Chlorine. |
|---|---|---|---|---|
| 1 | 3.15 | 0.95 | 2.21 | 0.15 |
| 2 | 24.93 | 6.59 | 18.34 | 1.39 |
| 3 | 7.36 | 1.43 | 5.92 | 0.79 |
| 4 | 5.31 | 1.28 | 4.03 | 0.51 |

The second result shows the very great pollution with which the river leaves Worcester. The amount of this pollution is said in the reports to be sufficient to give the water a dark, turbid appearance, which would lead one to expect a greater amount of impurity than the chemical analyses show. There is apparently an increase in the amount of impurity in the river at each of the points 3 and 4 above of about 50% from 1873 to 1888. It is evident that there is a considerable reduction in the proportional amount of pollution as the river flows. The great source of pollution is Worcester. A much smaller amount reaches the river below, almost altogether from factories. There is a considerable dilution of the water from comparatively unpolluted sources, the amount of which can be estimated from the extent of the water-shed above each point at which samples were taken, as stated above.

Of other rivers in the State we have some results for a year or two each in the cases of the Chicopee and Taunton, and others at frequent intervals from several smaller rivers and lakes which are used as sources of water supply and are therefore kept as clean as possible, and do not really belong to the class of streams we are considering. The results for the two rivers just previously mentioned are not numerous enough to make it worth while to reproduce them here. The State and the cities and villages interested are just entering upon the construction of a great system of sewers for the removal of sewage from the water-sheds of the water supplies of the Metropolitan District, which will thus render them quite free from pollution.

Many new results are promised in a supplement to the last report (1888) which has not yet appeared. Biological analyses are also in progress, but the results are not yet available.

The State Board of Health of Connecticut presents in its report for 1888 some general statements of the flow of certain rivers and of the amount of pollution they receive. There are a few results of chemical and bacteriological examinations, but they are too few in number to be of much value for purposes of comparison and need not be reproduced here.

In New Jersey the Passaic River has been used for many years as the source of water supply for Jersey City, Newark, and for portions of the time for other cities and villages. It also receives the sewage from several places and is somewhat polluted at the intakes by sea water. Chemical examinations of the water at various places have been made at frequent intervals and the increase of pollution in the course of the river and with time has been approximately determined. Some of these examinations have been made for the aqueduct boards of the cities, some for the joint board of Newark and Jersey City on the pollution of the Passaic, and some for the city of Newark in a suit for an injunction on the city of Passaic to prevent the discharge of sewage into the stream from the new sewer system in that city. But few of these results are as yet obtainable. I think that but few of them have been published. I extract a few characteristic groups from some that have been published, for which I am indebted to Prof. A. R. LEEDS, who made many of the examinations. Considerable work has been done by the "joint board" in reducing the amount of pollution from manufactories, and it is hoped that the final decision of the injunction suit will be favorable to the purity of the river, though the decision of the lower court is against the city of Newark. Some biological analyses have been made, but no organized investigation on this line has been entered into.

The following averages are taken from the report of Prof. LEEDS for 1883. The results of these averages are scattered through the year except in the case of the last two stations where the samples were taken in the spring months:

| Station | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| No. results | 11 | 11 | 1 | 2 | 4 | 4 |
| Free ammonia | 0.0122 | 0.0067 | 0.007 | 0.0115 | 0.0313 | 0.0048 |
| Alb. ammonia | 0.0240 | 0.0207 | 0.023 | 0.019 | 0.054 | 0.017 |
| Nitrites | 0.0007 | 0.0007 | None | 0.00005 | 0.0006 | ..... |
| Nitrates | 0.365 | 0.325 | None | 0.00003 | 0.00034 | ..... |
| Oxygen required | 0.46 | 0.40 | 0.39 | 0.43 | 1.17 | 0.40 |
| Chlorine | 1.54 | 0.69 | 0.55 | 0.55 | 1.02 | 0.35 |
| Hardness | 4.6 | 4.6 | 3.3 | 4.35 | .... | ..... |
| Total solids | 30.2 | 8.86 | 10.0 | 9.07 | 9.5 | 6.25 |

Station 1 is at the Jersey City intake, which is above the city of Newark, and is subject to some pollution from the sewage of that city brought up by the action of the tides.

Station 2 is at the Newark intake, which is further up the river, but is still within the influence of the tides and the sewage of the city of Newark. Both are below the cities of Paterson and Passaic and receive pollution from both sources, though that from Passaic has been small in the past as it is but just constructing a sewer system.

Station 3 is 2,000 ft. above the Newark intake and about at the upper limit of pollution from down-stream sources.

Station 4 is at the Avondale bridge and is practically out of reach of pollution from below except under unusual circumstances.

Station 5 is at the city of Paterson and the results here represent the effect of the sewage of Paterson.

Station 6 is above Beatty's Dam, above Paterson, and represents the stream in what may be called its original condition, as there are no sources of concentrated pollution above this point.

The work in the State of Pennsylvania has been principally in the line of investigation of the present and proposed water supplies for the city of Philadelphia. Detailed inspection of the water-sheds of the Schuylkill, the Delaware and some of its tributaries have been made and statements made of the sources of pollution from sewage and from manufacturing refuse. These reports are printed in the reports of the Water Department of the city of Philadelphia. Chemical examinations of the water from the various streams have been made at frequent intervals and the results published as above. I am indebted to Prof. LEEDS for the tables from which I abstract the following.

The first table gives the results of a series of samples, all taken on the same day at different points on the Schuylkill River, intended to show the increase in pollution in the course of the river. The first station is at Kissinger's Bridge above Reading, and all the larger sources of pollution and all sources except mines and mining towns. The second is at Pottstown, above Manatawny Creek, the third above Phœnixville pumping station, the fourth at the intake of the Norristown water-works, the fifth at the intake of the Conshohocken water-works, and the sixth at the Roxborough pumping station of the Philadelphia water-works Each station is farther down stream than the one before, and the river has received the additional pollution of the city above and other population, but has had some opportunity to purify itself in its flow to the point at which the sample was taken. The increase in pollution is evident on an inspection of the results. The exact nature of the polluting matters is given by the sanitary survey of Mr. D. C. BARBER, which gives the amount of population contributing to the pollution in each district and the method of drainage, and also the character of the polluting matter from manufactories and mines.

| Station | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Free ammonia. | 0.0035 | 0.0040 | 0.0025 | 0.0036 | 0.0010 | 0.0015 |
| Alb. ammonia. | 0.0140 | 0.0085 | 0.0100 | 0.0075 | 0.0140 | 0.0100 |
| Oxygen req'd. | 0.058 | 0.14 | 0.19 | 0.13 | 0.23 | 0.15 |
| Nitrites | ..... | 0.00005 | 0.00005 | 0.00008 | 0.0005 | ..... |
| Nitrates | 0.96 | 0.92 | 0.92 | 0.86 | 0.86 | 0.80 |
| Chlorine | 0.20 | 0.25 | 0.25 | 0.25 | 0.06 | 0.20 |
| Hardness | 2.5 | 3.5 | 3.70 | ..... | ..... | 3.0 |
| Total solids | 9.0 | 11.5 | 10.5 | 10.5 | 10.0 | 11.5 |

The following table shows the increase in pollution in the Delaware River with the increase in populated area draining into it:

| Locality | Water Gap. | Byram. | Frankford. |
|---|---|---|---|
| No. samples | 13 | 44 | 17 |
| Free ammonia | 0 00249 | 0.0028 | 0.00385 |
| Alb. ammonia | 0.0105 | 0.00988 | 0.0149 |
| Nitrous acid | 0.000005 | 0.000022 | 0.00004 |
| Nitric acid | 0.2393 | 0.2543 | 0.328 |
| Oxygen required | 0.29 | 0.315 | 0.308 |
| Chlorine | 0.227 | 0.266 | 0.329 |
| Total solids | 4.91 | 6.88 | 8.300 |

The amount of pollution above the Water Gap is very small, being from small villages, almost none of them having systems of sewerage. Byram is below the entrance of the Lehigh River and the amount of pollution is considerably increased. Frankford is close to the city and has the maximum of pollution.

In these reports are numerous sets of results to show the effect of the season of the year, the amount of water flowing, the covering of the surface with ice, the intermixture of tributaries, the addition of specific manufacturing refuse, and so on, which are very interesting and valuable, but we have no room for them here. I would refer any one wishing to examine the subject more carefully to the reports of the Philadelphia Water Department.

In the State of Illinois a very elaborate investigation of the Illinois River has been begun in connection with the discussion of the proposed discharge of Chicago sewage with a diluting volume of lake water into the Illinois River through the Desplaines. This investigation includes an examination of the water chemically, to determine the present amount of pollution at different points, and the ability of the river to purify itself, by aeration, oxidation or dillution. Bacteriological analyses are also in progress, and hydrographical surveys are also in progress. A preliminary report on the investigation is now in print, and I draw some of the results therefrom. The final discussion and conclusions must be left until the work is finished and the results digested.

The report of the hydrographical survey is very complete on the portion of the work already done, and covers a statement of the geological characteristics of the portion

* A paper by Charles C. Brown, read before the Engineers' Club of St. Louis, and reprinted in the *Journal of the Association of Engineering Societies* for October, 1890.

of the district examined; a discussion of the effects of inhabitation upon the high and low water levels; the population distribution, present and prospective; the extent of the basins tributary to the river, and detailed descriptions of the flow of water, levels and peculiarities of the Desplaines and Kankakee water-sheds, which two streams unite to form the Illinois River. The results of this investigation are of the utmost importance in the discussion of the particular case, and the method used can probably be advantageously employed in many similar investigations but they are in such shape, of necessity, that it is very difficult to do them justice in an abstract, and in this place, under my present limitations as to time and space, I will not attempt it.

Some chemical examinations of the water of the river at different points were made in 1886, many more were made in 1888 and 1889. I have combined the averages of these results in the following table for ease of comparison. The results for 1886 and 1888 are for samples collected in the summer months; those for 1889, in the winter months. This should be remembered as the rate of purification may be expected to be less in winter than in summer, though the actual pollution may at times be less in winter owing to the greater dilution. Some results for water flowing in the channel under ice are given in the report to show that the ice has a very marked effect in retarding the rate of purification of the water. An explanation of the peculiarities of each item so far as needed for our present purpose follows the table.

| No. | Date. | Total solids. | Suspended matter. | Chlorine. | Free ammonia. | Albuminoid ammonia. | Oxygen consumed. | Nitrogen in nitrates. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1886 | ..... | ..... | ..... | 2.656 | 0.163+ | 2.62 | |
| | 1888 | 47.12 | 12.92 | 4.68° | 1.225 | 0.256° | 2.31 | 0 |
| | 1889 | 37.66 | 2.72 | 6.29— | 0.892 | 0.281— | 2.65 | 0 |
| 2 | 1886 | ..... | ..... | ..... | 1.273 | 0.075+ | 1.10 | |
| | 1888 | 43.12 | 6.98 | 4.61° | 1.088 | 0.199° | 1.32 | 0 |
| | 1889 | 40.86 | 2.46 | 5.61— | 0.815 | 0.168— | 2.28 | 0 |
| 3 | 1888 | 44.17 | 9.40 | 3.91° | 0.745 | 0.167° | 1.57 | 0 |
| 3A | 1886 | ..... | ..... | ..... | 0.943 | 0.043+ | 0.93 | |
| | 1888 | 44.27 | 10.79 | 4.37° | 0.893 | 0.168° | 1.43 | 0 |
| | 1889 | 43.28 | 5.55 | 5.77— | 0.849 | 0.267— | 2.17 | 0 |
| (4) | 1888 | 29.47 | 1.41 | 0.58 | 0.042 | 0.035 | 0.47 | 0.031 |
| (5) | 1888 | 25.14 | 3.56 | 0.14 | 0.008 | 0.059 | 1.44 | 0.009 |
| 6 | 1888 | 35.59 | 3.08 | 3.21° | 0.411 | 0.071° | 1.09 | 0.038 |
| | 1889 | 32.28 | 2.91 | 2.87— | 0.472 | 0.159— | 1.07 | 0 |
| (7) | 1888 | 33.03 | 4.63 | 0.42 | 0.012 | 0.047 | 0.68 | 0.003 |
| 8 | 1886 | ..... | ..... | ..... | 0.041 | 0.024+ | 0.53 | ..... |
| (9) | 1888 | 45.06 | 8.78 | 0.55 | 0.013 | 0.034 | 0.69 | 0.036 |
| (10) | 1888 | 37.51 | 3.08 | 0.57 | 0.018 | 0.041 | 0.72 | 0.036 |
| 11 | 1888 | 34.57 | 5.03 | 1.97° | 0.064 | 0.053° | 0.86 | 0.104 |
| | 1889 | 41.76 | 9.38 | 1.31— | 0.146 | 0.064— | 0.86 | 0.094 |
| 12 | 1888 | 30.60 | 2.75 | 1.77° | 0.047 | 0.048° | 0.87 | 0.068 |
| | 1889 | 31.60 | 3.09 | 1.17— | 0.166 | 0.040— | 0.86 | 0.056 |
| 13 | 1886 | ..... | ..... | ..... | 0.063 | 0.019+ | 0.48 | ..... |
| | 1888 | 32.98 | 5.43 | 1.24° | 0.021 | 0.052° | 0.98 | 0.089 |
| 13A | 1889 | 33.10 | 2.69 | 1.29— | 0.164 | 0.055— | 0.96 | 0.051 |
| 14 | 1888 | 35.30 | 8.43 | 1.62° | 0.064 | 0.065° | 0.94 | 0.080 |
| | 1889 | 35.20 | 4.35 | 1.18— | 0.159 | 0.102— | 1.34 | 0.126 |
| 15 | 1888 | 30.18 | 4.54 | 1.16° | 0.034 | 0.043° | 0.81 | 0.073 |
| | 1889 | 35.44 | 8.08 | 0.93— | 0.108 | 0.05°— | 0.92 | 0.041 |
| (16) | 1888 | 31.78 | 7.07 | 0.36 | 0.005 | 0.028 | 0.55 | 0.075 |
| 17 | 1888 | 39.00 | 8.47 | 0.75° | 0.020 | 0.038° | 0.74 | 0.062 |
| | 1889 | 31.78 | 5.63 | 0.69— | 0.076 | 0.036— | 0.55 | 0.097 |
| 18 | 1888 | 30.16 | 5.03 | 0.92° | 0.069 | 0.048° | 0.73 | 0.028 |
| | 1889 | 41.08 | 4.46 | 0.75— | 0.087 | 0.072— | 0.98 | 0.009 |
| (19) | 1888 | 27.86 | 7.32 | 0.41° | 0.017 | 0.036° | 0.74 | ..... |
| | 1889 | 30.99 | 6.13 | 0.58— | 0.042 | 0.040— | 0.76 | 0.032 |

Results in ( ) are from tributaries of the Illinois.

No. 1 is at Bridgeport on the Illinois and Michigan canal, where 50,000 cu. ft. a minute of water are pumped from the South Branch of the Chicago River into the canal. The water thus pumped is very greatly polluted by the sewage of a half million or more of people in Chicago, as is shown by the analyses. This sewage is not fresh, but has had some opportunity to decompose in the river before reaching the pumping station. The relative amount of pollution varies somewhat from time to time as winds and currents vary the amount of water which is carried into the river from the lake. The method of taking the averages is said to eliminate to some extent the effect of this variation upon the results, in their relations to each other. It is evident that there is here no opportunity to study the question of increase in pollution with the time.

No. 2 is at Lockport, 29 miles down the canal from Bridgeport, with no dilution except from rain, and no sedimentation of the suspended matter because of the rapidity of the current and the action of passing boats. The purification depends then almost entirely upon chemical and organic action. That there is an appreciable amount of purification is evident from the table. The purification during the winter is less than during the summer, as shown by a comparison of the 1888 summer results with the 1889 winter results. These results give rather different conclusions from those in Massachusetts, where the principal sources of purification are said to be dilution and sedimentation.

No. 3 is at Lock 5 at Joliet. The Desplaines River and the canal unite at this point, but the flow of the river during the summer of 1888 was so small that its diluting effect may be neglected.

No. 3A is at dam 2, just below Joliet, 33 miles below Bridgeport. Between the two places at Joliet, the river receives the sewage of a part of Joliet and the State prison. The effect of this sewage is seen on comparing the two results for 1888 at No. 3 and No. 3A. The dilution by the Desplaines River in 1889 is probably considerably greater than in 1888, owing to an increase of flow in the winter. The effect of reduction in rate of purification, owing to the cold, is greater than the effect of dilution, as the table shows.

No. 4 is at Channahon, on the DuPage River, and shows the quality of one of the diluting streams. This stream is small and its diluting effect during the summer of 1888 can almost be neglected. The Desplaines River water-shed, including the DuPage, is 1,392 sq. miles.

No. 5 is at Wilmington, on the Kankakee River, and shows the character of an important source of dilution. The Kankakee water-shed is 5,146 sq. miles.

No. 6 is at Morris, below the entrance of the Kankakee. The total water-shed above the point is 7,296 sq. miles. An additional purification is observed.

No. 7 is from the Fox River above Ottawa. Its water-shed is 2,700 sq. miles.

No. 8 is at Ottawa in 1886, and is strictly comparable only with the results of that year.

No. 9 is from the Big Vermillion at La Salle. Its water-shed is 1,317 miles.

No. 10 is from the Little Vermillion at La Salle. Its water-shed is 165 miles.

No. 11 is from the Illinois River at La Salle. The total water-shed to this point is 11,847 miles.

No. 12 is at Henry. The area of water-shed above is 12,642 miles.

No. 13 is at Peoria, at the inlet to the water-works. The total water-shed above is 13,479 miles. No. 13A is at the upper bridge.

No. 14 is at Pekin. The area of water-shed is 13,831 miles.

No. 15 is at Havana. The area of water-shed is 15,364 miles.

No. 16 is on the Sangamon River, whose water-shed is 5,670 miles.

No. 17 is at Beardstown. Area of water shed, 23,444 miles.

No. 18 is at Grafton, near the mouth of the river, total water-shed, 27,914 miles.

No. 19 is in the Mississippi River at Alton, below the mouth of the Illinois.

The statements of area of water-shed give an idea of the comparative amount of water flowing at the different points and also some idea of the population, whose drainage enters the river directly or indirectly, if the metropolitan district is not considered. There are some data as to population in the report, but they are not in such shape as to be of use to us in this paper without more labor than I have time to put on it just now.

The data as to direct pollution from cities and towns and from manufacturing establishments are not enough to give much idea of the amount of pollution entering the river from other sources than the canal. That there is an appreciable amount of this pollution is shown by the increase in the amounts as indicated in the chemical analyses at some points down the river, far enough to be well out of the influence of the pollution with which the river starts. Doubtless additional information and discussion of this point will be given in the final report.

The original work in the State of New York has consisted principally of the investigation of the pollution of sources of potable water supply for various cities and villages of the State. By law the State Board of Health is empowered to make rules for the sanitary protection of water-sheds of corporations in the State, and has been called upon by several cities and villages to make such rules. I would refer to my paper before the club last year for a description of the method of investigation of New York City's supply. This was only a larger and therefore somewhat more fully treated example of the work done upon the various water-sheds.

Last year a law was passed that gave the State Board of Health certain powers over plans for sewerage and drainage of villages in the State taking advantage of the provisions of the act to construct sewers. One of the questions that arose very early in the discusion of such plans was as to the pollution of streams by the discharge from such sewers. In some cases the water is used below for village or city supplies, and there is a possibility of detrimental action upon such water. This is, of course, the case with tributaries to the Hudson, which is used for water supply until salt water is reached, viz., to Poughkeesie. The board has therefore thought it best to institute an investigation of the question and an inspection of the Hudson has been begun. Some work was done last summer, but not enough results have been yet secured to warrant their publication, except as to a minor matter, not touched upon in this paper. In working out a plan for the investigation I have gathered the data of which I have tried to give you some idea above.

All the work on the subject that I have been able to get reports of has been touched upon above, except some investigations of small streams for water supply. I am very anxious to get hold of anything else that has been done, and that is one of the objects with which I have written the paper. It is very evident from the above statement that very little indeed has been done on the subject in this country, and it is also evident that all that has been done shows that the question is a very important one. The more thorough the work the more evidently is it shown that the continued use even of our largest rivers as both sewers and sources of water supply cannot be permitted. The larger the river and the more favorable the conditions of purification the longer this double use can be continued, but in the more thickly populated portions of our country the use of even the largest rivers is becoming questionable.

I would be glad to have an expression of opinion from members of the club upon the following statement to which my present knowledge of the subject leads me. Granted the importance of the investigation and the necessity of some action in the matter, the most practical course of procedure is to make a detailed inspection of the water-shed of the steam in question to determine the actual sources of pollution and the amounts thereof and the nature of the effect upon the water. Data as to the amount of the minimum flow of water, which occurs at the time of maximum pollution in most cases, should also be determined. The location of the great sources of pollution and the distances through which the river flows from one to another are important data. Data as to the increase in pollution, with the time, are of value to form an estimate of the probable length of time until the stream must be abandoned as a source of water supply. These can be obtained by determining the increase in population, the increase in extent of sewerage systems, in manufactures etc.

With this knowledge at hand we can examine the results of chemical examinations of the water, samples being taken from places judiciously selected and in considerable numbers at frequent intervals, and feel as though we could understand what the results mean and of what value they are in any particular case.

The subject of the biological analysis of water is a very new one, and it is difficult as yet to say how valuable it may be. I therefore place it last in importance, but I am disposed to think that our principal line for advance is in this direction, and that in the future the methods of biological analysis will be improved and this manner of investigating water assume a high rank.

The world is very young in this matter, and our theories do not fit all the facts. I have not attempted to give anything more than as brief a statement as possible of the work that has been done in this country from the practical standpoint, and have let the theories severely alone for the present. The chemical analyses appeal more clearly to the eye than any results of inspections or counts of bacteria, and I have therefore confined the statistical part of the paper to them.

I must beg your indulgence for the form and the fragmentary nature of the paper on the score of lack of consecutive hours and of enough of them to put it into good shape.

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THE GREATHEAD SYSTEM OF TUNNELING THROUGH SOFT MATERIALS is now accepted as an established method of engineering practice. The experience at the St. Clair tunnel and in the City and South London Subway has fully demonstrated its reliability, at least in the minds of such distinguished engineers as Sir BENJAMIN BAKER. A year ago a committee of the London County Council was instructed to proceed with preliminary experiments, to the cost of £10,000, to ascertain the practicability of a tunnel under the Thames at Blackwall. The committee consulted Sir BENJAMIN BAKER, who, after inspecting the St. Clair and Hudson River tunnels, advised against any expenditure on preliminary work. Beyond the usual borings, considering that the practicability of the enterprise was thoroughly proved, and that the appropriation had better be expended on the permanent work, Sir BENJAMIN said that the experience at St. Clair showed that a 21-ft. tunnel could be driven at a cost of about £50 ($242.50) per lin. ft. This is considerably below the estimates of the final cost of the St. Clair tunnel as given in our issue of Dec. 27; but the experience gained there will probably enable reductions to be made in driving other tunnels. It is proposed to make the Blackwall tunnel 23 ft. in internal diameter—2 ft. larger than the St. Clair.

## The General Plan for the World's Columbian Exposition.

The plan on next page, for which we are indebted to Mr. A. GOTTLIEB, Consulting Engineer, shows the location of buildings for the World's Columbian Exposition at Jackson Park, Chicago, as finally adopted, and also the location of the terminal facilities for railway transportation. Taken together with the following description of the exposition grounds, the general outline of the exposition as it is to be can now be pretty well understood. The plan and description given herewith are the first accurate ones which have appeared.

There will be an intramural elevated electric railway inside of the grounds, the location of which has not been definitely determined yet, so that it is not shown on the map herewith, nor where the connection with the city elevated railways and cable roads will be. All these points are still under consideration. We are informed further that the authorities are now well advanced with their plans for water supply and sewerage, and with the details of some of the buildings.

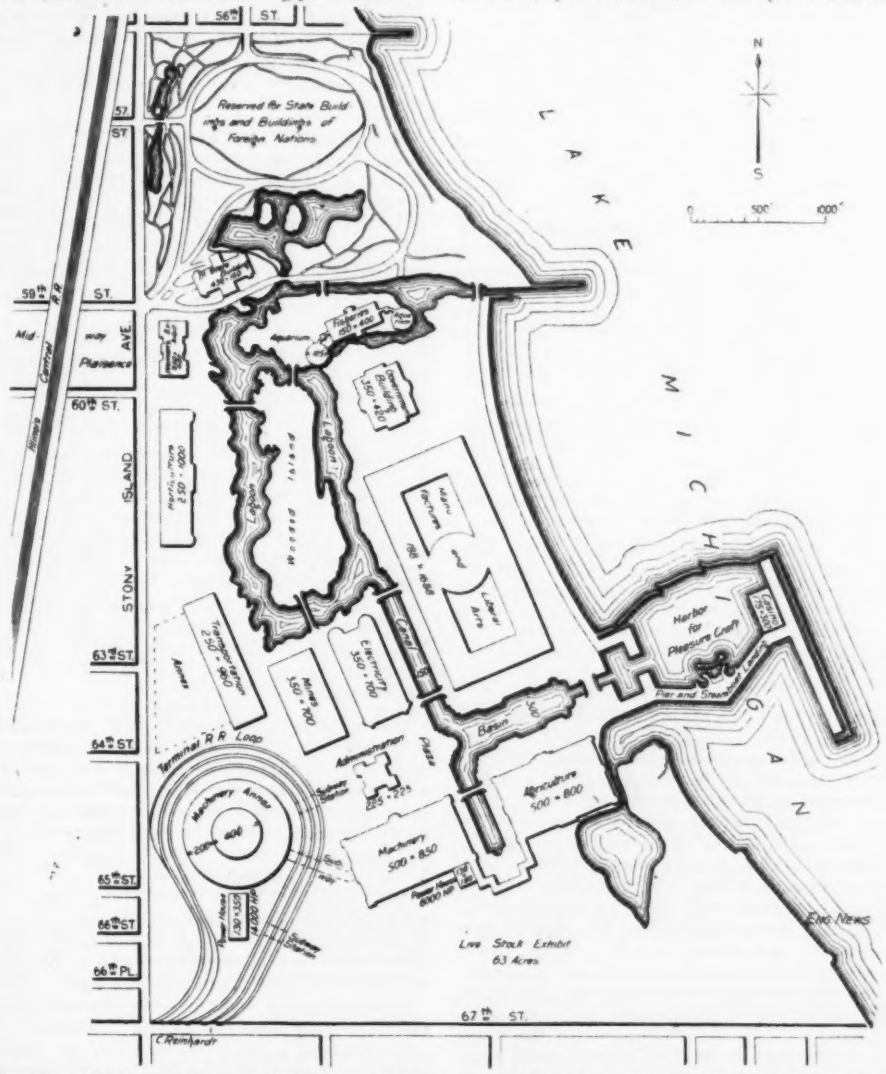
There is a private corporation which intends to put up a steel tower about 1,300 ft. high, and if it should be built it will probably be located on that portion of Midway Plaisance which is between the Illinois Central R. R.'s right of way and the west line of Stony Island Ave.

The naval exhibit of the government, if there should be any, will probably be located in the lake south of the pier which extends into the lake at Fifty-ninth St.

Jackson Park, the point selected for the main portion of the exposition of 1893, is located within the corporate limits of the city of Chicago, upon the banks of Lake Michigan, about 7 miles southeast of the center of the city, as shown on the accompanying map, and is a tract of land comprising 560 acres. The north portion of 120 acres is now improved as a public park. This portion it is proposed to set apart for special buildings of the several states of the Union and of foreign nations; that of the state of Illinois having already been located at the southwest corner near Fifty-ninth St., the state authorities, having their plans perfected and accepted, will erect a building about 450 ft. in length by 160 ft. in width, of which W. W. BOYNTON & Co., of Chicago, are the architects. The unimproved portion of the park, or that portion situated between Fifty-ninth and Sixty-seventh Sts. and between Stony Island Ave. and Lake Michigan, 440 acres in extent, is now being improved and graded for the purposes of the exposition, upon which will be located the general national exhibit, with buildings about as follows:

N
S
LAKE MICHIGAN
5 Miles
4 M's
3 M's
2 M's
2 Miles from Court House
3 M's
4 M's
5 M's
6 M's
7 M's
8 M's
9 M's
10 M's
11 M's
12 M's
13 M's
GRACELAND
ROAD
BELMONT
AVE.
FULLERTON
AVE.
NORTH
AVE.
CHICAGO
AVE.
MADISON
ST.
HALSTED
ST.
ST.
ST.

& WHITEHOUSE, of Chicago, are architects. This building will be used for open-air concerts and cafés and as a pleasure resort for visitors. On the south the pier is expected to be used as a landing place for the steamboats carrying visitors to the exposition. This harbor and basin will be further protected by a breakwater pier upon the northward. Boats of many foreign countries will be placed upon these waters, showing their diverse flags and sails, with boatmen in native attire. South of the buildings for machinery and agriculture is the proposed location for the stock exhibit, a tract of land 63 acres in extent. In the southwest corner of the park is located the terminal station, where the railway system of Chicago will deliver visitors to the fair. This is a system of 6 parallel tracks, with loading platforms and




MAP OF JACKSON PARK, CHICAGO; SHOWING PROPOSED ARRANGEMENT FOR WORLD'S COLUMBIAN EXPOSITION OF 1893.

stations at convenient points. It is planned to reach these loading stations by means of subways from various points of the ground passing under the tracks and rising again to the platforms upon inclined planes.

The general plan for improving the grounds is to surround each building with a walk of 40 to 60 ft. in width, constructed of some substantial material, then dropping down about 4 ft. to a terrace laid out with grass plots, flower gardens, etc. Messrs. F. L. OLMSTED & Co., of Boston, are the landscape architects, which is a sufficient guarantee that all that good taste can do will be done for the grounds.

At the northwest corner of the unimproved portion of the park abuts the Midway Plaisance, a tract of land 600 ft. in width by one mile in length, upon which it is expected to locate the typical villages of various foreign nations. Entering the ground from the midway plaisance, and crossing the Illinois Central R. R. tracks, will be located an elevated double-track, intramural railway, touching the buildings of horticulture, transportation, machinery annex, machinery, agriculture and stock exhibit; also another system entering at Midway Plaisance, passing through the improved portion of the park, and touching upon various state and foreign buildings, fisheries and the government exhibit.

A complete system of sewerage, water supply and fire protection is being designed, using only modern methods and appliances, and it will be made fully adequate to all needs. The city of Chicago will erect two new pumping engines for the use of the Exposition, with a capacity of 24,000,000 galls. of water per day.

Jackson Park is now reached by the Illinois Central R. R., and (in close proximity) the South Side cable line, by the lake marine and by the boulevard system of the city. It is expected that the South Side cable line and at least two systems of elevated railway will extend their lines to a point within the grounds, or at least to a point very near thereto.

The general plan of construction for all the exhibition buildings is to be all steel and iron so far as required for stability, but where it is possible to do so, timber and combination construction. The ornamentation and architectural effect will be mostly secured by means of mast, being made of forms of plaster upon backing of burlaps, which is very light and susceptible of being formed into close imitation of stone and iron. Further ornamentations of glass and canvas will be used freely. We trust care will be taken to ensure that all these attempted "ornamentations" are truly such. Ease in constructing them has before now proved a fatal bit of good fortune, but the names of the eminent architects engaged on these designs give some reasonable assurance that instances of shockingly bad taste, at least, will not occur.

The grounds will be beautified by flower beds and ornamental statuary, and by electric fountains and brilliant electric illumination over all the grounds and in all the buildings during the evening.

From the dimensions given above we have computed the following table of proposed areas under roof, to which we add for comparative purposes the corresponding areas for the Exposition of 1876, from which it will be seen that in grandioseness at least, and we trust in true grandeur, the Exposition of 1893 is to be far ahead of all predecessors.

| *Kind of building.* | Chicago, 1893. Size. | Acres. | Philadelphia, 1876. Acres. |
|---|---|---|---|
| Manufact'es and Liberal Arts | 788 × 1,688 | 30.538 | 20.200 |
| Machinery Hall | 500 × 850 | 9.757 | 1.950 |
| Machinery Annex | 800 diam. | 9.654 | |
| Electrical Building | 350 × 700 | 5.625 | 14.000 |
| Mining Building | 350 × 700 | 5.625 | |
| Transportation Building | 250 × 960 | 5.509 | |
| Power Buildings | 130 × 500 | 1.492 | 0.526 |
| Agricultural Hall | 500 × 800 | 9.183 | 8.720 |
| Fisheries | 150 × 400 | 1.377 | ..... |
| Horticultural Hall | 250 × 1,000 | 5.739 | 1.250 |
| Aquariums | 225 diam. each | 0.564 | |
| Government Building | 350 × 420 | 3.375 | 2.330 |
| Women's Building | 200 × 400 | 1.837 | 0.800 |
| State Building (Ill.) | 430 × 160 | 1.578 | Pa. 0.160 |
| Administration Building | 225 × 225 | 1.162 | 0.740 |
| Total in comparable structures | | 93.044 | 50.685 |
| Other minor structures at Philadelphia. | | | 20.781 |
| Total area under roof at Philadelphia. | | | 71.466 |

It has been finally decided that no buildings whatever will be erected on the so called "lake front," near the center of the city, but that all shall be in one enclosure—very wisely, it seems to us

## Pressed Steel in Car Construction.*

From the best information that I can gather I estimate that about 12,000 tons of pressed steel has gone into car construction during the past 2½ years, consisting of spring plates, journal-box lids, center plates, stake pockets, side bearings, drawbar attachments, deadblocks, corner bands, etc.; and from all that I can learn these various articles are doing good service.

The greatest drawback to the introduction of the various articles is the multitudinous number of sizes of the same article, the impossibility of getting the gentlemen constituting the mechanical department to see eye to eye in the matter of standards. As one of them said to me a few days ago while going through our works, "We meet in convention, discuss and adopt standards, then go home and keep on doing as we please." As an illustration of this, the Schoen Manufacturing Co. has between 70 and 80 sets of dies for center plates and about 100 sets of dies for stake pockets alone. There ought not to be any necessity for more than one-half dozen sizes of either of these articles. This same difficulty follows in nearly everything about a car, and it is readily seen that the various articles cannot be produced as cheaply as they could if this large expense for dies was eliminated from the cost. Besides, the cost for repairs is largely increased because of the delays occasioned in getting material for repairs for foreign cars having different patterns. You are all, of course, familiar with this trouble in the present practice in patterns for cast iron, and this knowledge should influence you very favorably toward the adoption of standards in pressed steel in its early stages, thus avoiding what in the future would be a constant source of expense, as is now the case in the old practice.

The advantage of using a homogeneous metal in car construction, such as we have in low carbon steel, is certainly apparent. We have a metal that will withstand shocks without injury far beyond that of cast iron, and in consequence of this the expense for repairs is largely decreased.

The weight of the various articles in pressed steel, which are substituted for castings, will average about one-third the weight of the cast iron displaced, and, assuming that there have been 12,000 tons of pressed steel articles used up to the present time, as stated above, it has displaced 36,000 tons of cast iron. Deduct the weight of the steel (12,000 tons), and we have a net saving of 24,000 tons of dead weight. It costs just as much to haul that 24,000 tons of surplus weight as it does to haul that amount of paying freight.

The cost of hauling this extra weight Mr. SCHOEN computed to be no less than $500,400 per annum, estimating the cost of hauling dead weight at 0.236 ct. per ton mile, and the average car mileage at 10,000 miles per annum. This would be somewhat modified by the proportion of cost charged to general expenses.

Mr. SCHOEN predicted that in the near future a

* Condensed from a paper by Mr. CHAS. P. SCHOEN President Schoen Mfg. Co., Pittsburg, Pa., read before the New York Railroad Club.

car built of steel throughout will be the popular car, and continued :

The cost of steel is growing less from year to year until even now a steel car can be built very closely approximating the cost of a first-class wooden car as at present constructed. The Harvey Steel Car Co., of Chicago, I understand, is at present engaged in building 25 of its steel cars. The Fox Pressed Steel Co. is engaged in developing its pressed-steel car truck, and has the utmost faith in its success. The Schoen Manufacturing Co. is at present engaged in making preparations to build a number of steel cars, and proposes to put them in service and let them run and develop any possible weak points or mistakes in design, with a view of preparing to build these cars in a regular way. It is confidently believed that a steel gondola car of 30 tons capacity can be built thoroughly well, and the weight will be less than 19,000 lbs. This is a saving in dead weight of several thousand pounds over the ordinary wooden car; and as a vehicle for the transportation of freight, its value is as much greater than a wooden car as the cost of transporting the dead weight in the wooden car would amount to, less any differences that there might be in expense of keeping the car in repair; and it is fair to presume that the cost for maintenance would be less than it would be in a wooden car.

The constant reduction in cost of steel, and the growing scarcity and consequent increase in cost of timber, the reduction in dead weight; the probability that they will last twice as long as a wooden car, are most certainly strong reasons why all developments looking to the introduction of a steel car, either in whole or in part, should and will be viewed with more than ordinary interest by railroad men and investors in railroad securities; and it is to be hoped that the committee appointed at the last Master Car Builders' Convention to look into and report on this question will furnish some valuable information on the subject.

The art of shaping steel in dies is a very interesting study. Many things can be made from pressed steel of considerable thickness that the ordinary worker of metal would hardly credit. This is due to the developments in the art partly, and partly to the uniformity in quality and cheapness of the steel as produced to-day. A few years ago this industry could not have been developed because of the high cost of material. To-day, however, steel shapes can be substituted for castings without increasing the cost of construction, except in cases where extremely light castings are used.

In the discussion, Mr. BARNES, of the Fox Steel Co., said that the presses of the Fox Co., at Joliet, Ill., are the largest in the world. They will take sheets of steel as large as 24 ft. × 9 ft. There is no monopoly in the manufacture of pressed steel, as about a dozen different manufacturers are now engaged in the business, and some of the locomotive works make their own pressed steel. To test the strength of the pressed-steel truck made by the Fox Co. it was loaded with 90,000 lbs. and run at high speed over a yard curve. The truck failed by rolling over. The safe carrying capacity is at least double that of the ordinary truck, and its weight is 1,000 lbs. less.

## A Remarkable Rainfall.

The destructive floods in Arizona and in San Diego Co., Cal., which occurred about the close of February, were exceedingly remarkable, because of the heavy rainfall in a district which is generally the most arid and rainless of any in the United States, if not in the world. The average annual rainfall at Yuma, Ariz. is only 2.92 ins. and, as may be seen by an examination of our monthly weather reports, there is often no rain at all there for months together. During the month of February, however, as may be seen by the table in another column, Yuma had the very respectable rainfall of 2.53 ins., of which 1.91 ins., or about three-fourths the average annual rainfall, fell in 24 hours.

It may be remembered that Associated Press dispatches on Feb. 27 reported a total rainfall of 33 ins. in 60 hours at Cuyamaca dam, in San Diego Co., about 40 miles east of the city of San Diego. Through the courtesy of Mr. JAS. D. SCHUYLER, we have been placed in possession of the facts concerning this remarkable rainfall, which, while not so heavy as at first reported, was still of phenomenal volume, and especially notable because of its occurrence in a county where the rainfall is usually very moderate. The average rainfall at San Diego is only 12 ins. per annum. Mr. SCHUYLER writes us as follows:

I have your favor of Feb. 28 inquiring about rainfall. The San Diego Flume Co. has a rain gage at the dam at the Cuyamaca Reservoir, and an observer, who is said to keep an accurate record of rain and snow fall. During the storm referred to his record shows that 23.40 ins. fell in 54 hours, of which 13 ins. fell in 13 hours, and 7 ins. in 10 hours.

The elevation of the reservoir is about 4,500 ft. above sea level. The highest surrounding mountains are 6,500 ft. above sea level, and lie to the west of the reservoir between its watershed and the direction whence the storms come. The eastern boundary of the basin is on the rim of the desert at an elevation of not over 5,000 ft. The area of the watershed above the dam is but 11 sq. miles. The topography of the country is such that a rain gage at the dam would not be likely to indicate the maximum precipitation on the three Cuyamaca peaks that bound the watershed on the west.

Taking all the data I can gather as to the duration of overflow over the spillway, and through the main outlet gate, which was kept wide open for three days, I have computed the amount drained off the watershed in the first week after the storm at somewhat less than 50% of the average recorded rainfall at the dam.

A rainfall of 13 ins. in 23 hours is among the heaviest on record in the United States. General GREELY's book, "American Weather," gives a great number of instances of heavy rainfalls, but the following are the only ones which exceed the above record: Mayport, Fla., Sept. 29, 1882, 13.7 ins. in 24 hours; Newtown, Del. Co., Pa., Aug. 5, 1843, 13 ins. in 3 hours; same date, at Concord, Pa., 16 ins., in 3 hours, and at Brandywine Hundred, Pa., 10 ins. in two hours. The most notable thing about the above remarkable rainfall, however, is that the place where it occurred is within a few miles of one of the very driest regions in the world. The average annual rainfall at Indio, San Diego Co., a station on the Southern Pacific Ry., about 50 miles east of the Cuyamaca dam, is given by General GREELY as but 1.92 ins., and he says of this and Camp Mohave, Ariz., where the average rainfall is but 1.85 ins.:

These stations doubtless have the smallest known rainfall on the face of the globe. Statements have been frequently made that rain never falls in these localities, but there is no year at any station where a measurable rainfall has not been recorded, the least observed being that at Indio, 0.10 in., during the seasonal year 1884-85.

It is proper to add that the San Bernardino mountain range lies between Indio and the Cuyamaca watershed; but that the storm during which this excessive rainfall occurred was not a local one is seen by the unusually heavy rainfall at Yuma, 120 miles to the east of Cuyamaca.

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THE MOVEMENT FOR BETTER ROADS has been taken up by the Illinois Society of Engineers and Surveyors, which has petitioned the legislature to appoint a commission of three senators, five representatives and five citizens to be appointed by the governor, two of whom shall be civil engineers, to report to the next legislature on the most practicable legislation to facilitate improvement of roads. The present law permits assessments up to 60 cts. per $100, or about $2,400 per average township, with an average of 60 miles of highways. The highway commissioners can at times levy 20 to 40 cts. more, and the township can vote to raise still more; but this and another "permanent road law" are practically dead letters. It is desired to imitate the Ohio law, by which the county bears one-fifth, the township one-fifth and the property owners three-fifths of permanent improvements, improvement bonds being issued to distribute the expense over a term of five or more years; but even this cannot be done without a constitutional amendment. Therefore a commission is sought meantime.

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THE NEW YORK ADVISORY STREET CLEANING COMMISSION, consisting of Capt. F. V. GREENE, Prof. C. F. CHANDLER and three other well-known citizens, has, after some three months' investigation (including one month's trial of two systems), submitted a long report to Mayor GRANT, which we shall hereafter abstract more fully when the complete report reaches us. The substance of the report, when stripped of its courteous circumlocutions, is that the department is steeped in politics and wastes money in various ways, and that the present expenditure, even if well managed, is not quite large enough to clean all the streets thoroughly well. For the latter purpose $1,800,000 per year would be required; to clean about 40% of the streets thoroughly well and the rest by machinery fairly well would cost $1,500,000; to clean all the streets fairly well (which means much better than they have ever yet been cleaned), about the present expenditure of $1,250,000, with the sole change of expending all of it for street cleaning and none of it for political purposes.

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A NOVEL USE OF A LIGHT ENGINE, an expansion of the general method which has been in use for some time on the high Chicago buildings, is to mount a donkey engine working a crane on a tram car, which is itself propelled by the engine along a track laid along the floor pieces of the building. The car is operated by one man, and is used in hoisting and placing in position the structural iron of the successive stories. When the uprights and crosspieces for another story are all in position, an inclined tramway is laid from the floor on which the engine has been working to the one above, which has just been built by means of the machine. A pulley is attached to the upper end of the tramway and a wire rope is fixed to the car, carried over the pulley, and brought back to the drum on the car. The engine is set in motion and drags itself up the incline to the next floor, where the same process is repeated.

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THE FOURTH RAILWAY ON LOOKOUT MOUNTAIN is now under construction. As most of our readers know, this is a broad-topped mountain, nearly 2,000 ft. in height, about 4 miles from the city of Chattanooga. Since the construction of railway lines making the summit easy of access, it has become an important suburb of Chattanooga, and one of the most popular summer resorts in the South. The first railway up the mountain was a cable incline road built in 1887 under the direction of Maj. W. R. KING, U. S. Engrs. This line is 4,360 ft. in length, and has a total rise of 1,170 ft. It terminates beneath Lookout Point, some distance below the summit of the mountains. From its terminus a narrow-gage line runs a distance of about 2 miles to the top of the mountain, The incline road was fully described in our issue of Jan. 7, 1888. In 1888 a standard-gage railway was built about 10 miles in length, with a uniform grade of 1¼%. This terminates on the highest part of the mountain, in front of the famous Lookout Inn. The fourth road is to be a cable incline railway, terminating on the top of the mountain, near the same point as the standard-gage road, and having grades from 14% to 80%. Work is being carried on night and day to have the road ready for summer traffic. Mr. FRANK C. ROBERTS, of Philadelphia, is Chief Engineer.

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THE LARGEST GOVERNMENT SNAG BOAT on the upper Mississippi is of about the dimensions of the *Sidney* in the list below, draws 39 ins. light, cost $18,000 to $20,000 per year to run, all told, and last year did the following work, which must be regarded as a pretty fair return on the money:

| | |
|---|---|
| Snags removed | 299 |
| Leaning trees pulled back | 78 |
| Leaning trees felled | 1,613 |
| Wrecks removed | 3 |
| Posts and ring bolts put in | 31 |
| Steamboats assisted | 12 |
| Boulder removed | 1 |
| Cubic yards of rock put in dam | 1,183 |
| Miles run | 6,807 |

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STEAMBOATS ON THE UPPER MISSISSIPPI are of amazingly small draft, as shown in a table in the report of Major A. MACKENZIE, U. S. A., ranging all the way from 16 to 53 ins., the last only occurring on very large boats of over 900 tons, and boats of nearly that size sometimes drawing only 30 ins. The following are the five of largest size in a list of 137 boats on the Upper Mississippi:

| Name of boat. | Built in | Hull. Lgth. ft. | Hull. Wth. ft. | Hull. Dth. ft. | Over all. Lgth. ft. | Over all. Wth. ft. | Draft, light, ins. | Register tons. |
|---|---|---|---|---|---|---|---|---|
| War Eagle | 1876 | 279 | 41 | ..... | 281 | 72 | 33 | 954 |
| Pittsburg | 1879 | 256 | 39 | 5.8 | 278 | 46 | 30 | 722 |
| Sidney | 1880 | 221 | 35½ | 5½ | 245 | 42 | 28 | 618 |
| City St. Paul | 1883 | 300 | 37 | 6¼ | 302 | 69 | 30 | 804 |
| S. W. Parker | 1888 | 266 | 46 | 7½ | 275 | 70 | 24 | 995 |
| L. Houck | 1889 | 210 | 37 | 6¼ | 240 | 44 | 53 | 913 |

The extreme height of stack above the water line is 66 ft., but only 15 boats exceed 50 ft.; and only 5, 55 ft. The draft loaded is not given, but can readily be approximated to by calculation; the first boat, for example, will displace about 289 tons of water per 12 ins. of extra draft.

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ALMOST CHEMICALLY PURE ALUMINUM, running as high as 99.93% pure and all of it over 99.60%, is now being turned out by the Pittsburg Reduction Co. This is a considerable advance on the prior standard

of purity, which seemed a tolerably good one, and is owing of course to continued improvements in the process.

A LARGE SKEW ARCH BRIDGE will be built in Baltimore, Md., from designs prepared by Mr. F. H. SMITH. There will be 3 semi-elliptic spans from 130 to 140 ft. long by 100 ft. wide on a 30° skew. The material will be obtained from neighboring slate quarries, except the facings, which are to be of marble. Mr. SMITH is also preparing plans for an elevated road 4,000 ft. long for the North Avenue Electric Ry., and for a large pier, 800 × 48 ft., for the Baker Whiteley Coal Co.

PROSPECTING WITH THE DIAMOND DRILL is carried on at government expense in the colony of Victoria, Australia, according to the *Mining and Scientific Press*. The drills are owned and worked by the government. Five are now employed in prospecting for coal and ten are working in the gold districts. During the last three months the total number of feet bored was 10,029.

A LARGE BRIDGE IS TO BE MOVED on the Grand Trunk Ry., near Kingston, Ont., where the main line is being double tracked. A new double track steel span, 107 feet long over all, 30 feet in width between truss centers, and containing 276,000 lbs. of steel, has been erected alongside its intended location, and is to be rolled into place between trains. The Pennsylvania R. R. has moved much larger bridges than this, however. In our issue of Oct. 22, 1887, we described and illustrated the moving of the Conestoga bridge on that road, a double track structure, 349 ft. long and weighing 450 tons. The bridge was moved 44 ft. 6 ins. in 15 minutes, and the first train passed over the bridge in its new position within 80 minutes from the time the rails were cut.

COAL PRODUCTION WEST OF THE MISSISSIPPI RIVER increased more than threefold during the past decade, or from 4,584,324 tons in 1880 to 16,067,500 tons in 1889. The value per ton at the mines decreased from $1.93 in 1880 to $1.52 in 1889. The following table gives the production by states in the census year 1889, arranged in the order of their tonnage:

| States. | Product, tons. | Av. price per ton. | No. of mines. Regular establishm't. | No. of mines. Local mines. |
|---|---|---|---|---|
| Iowa | 4,061,704 | $1.33 | 172 | 223 |
| Missouri | 2,567,823 | 1.35 | 123 | 356 |
| Colorado | 2,360,536 | 1.53 | 33 | 40 |
| Kansas | 2,230,763 | 1.48 | 127 | 295 |
| Wyoming | 1,388,947 | 1.26 | 15 | 10 |
| Washington | 993,724 | 2.22 | 12 | ... |
| Indian Ter | 752,83 | 1.76 | 10 | ... |
| New Mexico | 486,983 | 1.79 | 18 | 12 |
| Montana | 363,301 | 2.43 | 8 | 22 |
| Arkansas | 279,584 | 1.42 | 8 | 16 |
| Utah | 236,601 | 1.60 | 4 | 7 |
| Cal. and Ore. | 186,179 | 2.43 | 10 | 1 |
| Texas | 128,216 | 2.65 | 4 | 6 |
| Dak. and Neb. | 30,307 | 1.53 | 5 | 338 |
| Total | 16,067,500 | $1.52 | 569 | 1,326 |

This leaves only Nevada, Idaho and Arizona among the non-producing states west of the Mississippi. Indications of lignite deposits have been found in these states, however, and workable deposits may yet be found.

## PERSONALS.

Mr. WISTAR MORRIS, a Director of the Pennsylvania R. R. Co., and head of the iron firm of Morris, Tasker & Co., died at Overbrook, Pa., March 23.

Mr. J. W. SHIPMAN, formerly of the New York Bridge Co., and until recently the New York agent of the Pennsylvania Bridge Co., died in New York, March 25.

Maj. E. L. TYLER, General Manager of the Atlanta & West Point R. R., has been elected President of the Atlanta & Florida R. R., vice Mr. ROBERT MADDOX, resigned.

Lieut. GEO. W. GOETHALS, U. S. Engineers, has been appointed Engineer in Charge of the Tennessee River improvement below Chattanooga, Tenn., including the Muscle Shoals Canal.

Maj. HAMILTON WILKINS has been appointed Superintendent of the Macon & Covington R. R. He will retain his position as President and General Manager of the Augusta, Richmond & Sandersville R. R.

Mr. CHARLES KELLOGG, who died at Findlay, O., March 14, as noted last week, was a prominent bridge engineer and contractor, and organized bridge companies at Detroit, Mich., and Buffalo, N. Y., which still exist. For the past few years he had devoted himself to the perfecting of his invention of a process for rolling steel tubes direct from the ingot. Works have been established at Findlay, O., for this process.

Mr. LEVI C. WADE, President of the Mexican Central Ry. Co., died at Boston, Mass., March 20. He was born in Allegheny County, Pa., in 1843, and studied law. In 1880 he was made Assistant Counsel of the Atchison, Topeka & Santa Fé R. R. He was for a time Vice-President of the Sonora Ry. Co., and also General Solicitor of the Atlantic & Pacific R. R. He then became Second Vice-President of the Mexican Central Ry., and in 1881 was made President of the company. He was one of the four original projectors and owners of the Mexican Central Ry.

## NEW PUBLICATIONS.

*Report of the Boston Water Board for* 1890. Pamph., pp. 144; illustrations and diagrams.

The work of protecting the purity of the water supply of Boston is being continued with gratifying results. Aside from measures to prevent minor contaminations of the sources of supply, a contract was made with the town of Marlborough whereby the sewage of its 13,000 inhabitants will be entirely removed from the Sudbury watershed. Boston contributes $62,000 towards the expense of this removal. Negotiations are also pending for the conveyance of the sewage of the town of Westborough, with 5,000 inhabitants, outside the Sudbury drainage area. These systems will make use of filtration, and will be modeled upon that for the town of Framingham, in the Cochituate division of the works, toward the expense of which Boston also contributed. The three towns of Framingham, Marlborough and Westborough have a combined population of 28,239, and the diversion of their sewage from the sources of Boston's water supply cannot fail to improve the quality of the water.

The rainfall and quantities collected on the several water-sheds for the year 1890 were as follows:

| | Sudbury. | Cochituate. | Mystic. |
|---|---|---|---|
| Rainfall, inches | 53.00 | 51.23 | 49.37 |
| Rainfall collected, inches | 26.908 | 24.51 | 26.04 |
| Daily average yield, galls. | 96,658,100 | 22,023,100 | 33,323,300 |

It will be seen that, with the exception of the Mystic, slightly over half of the total rainfall on each water-shed was collected.

A new dam is being constructed near the source of the Sudbury River. Two reproductions of photograpns show work in progress upon the dam, one showing the site with the heart-wall under construction, the other the bottom of the heart wall trench, with sheeting and bracing.

Two diagrams show graphically the rainfall, consumption of water and heights of water at the various ponds. The diagrams showing rainfall and consumption cover the 16 years, 1875 to 1890, inclusive. Numerous tables supplement the diagrams. There are also tables of temperatures and analyses of water.

The work of inspection to prevent waste was carried on during the year with the usual vigor and good results. The work done by the inspector, was as follows:

| | |
|---|---|
| Premises inspected | 61,633 |
| Notifications to repair defective fixtures | 10,402 |
| Premises re-examined | 10,643 |
| Second notices to repair defective fixtures | 383 |
| Second re-examinations | 1,836 |
| Wilful waste notices issued | 178 |
| Fines collected | 5 |
| Cases of unpaid hose reported | 536 |
| Violations of hose regulations | 132 |
| Defective services in streets | 104 |
| Hopper water closets reported as not self-closing | 38 |

It will be seen that nearly one-sixth of the premises examined were found to have defective fixtures. That inspection pays is shown by the statement that the present consumption of water is but little more than in 1883, notwithstanding the increase in population. The report states that there still remains a large amount of waste.

—*Water-Works Reports.*—The following water-works reports for 1890 have been received, the gentlemen named being superintendents, unless otherwise stated: Keene, N H., P. F. BABBIDGE; Woltborough, N. H., I. B. MANNING, Commissioner; Boston, Mass., DEXTER BRACKETT, Superintendent Eastern Division Cochituate Department, Greenfield, Mass., C. T. WILEY, Commissioner; Hopkinton, Mass., HENRY MCFARLAND, Commissioner; Hudson, Mass., D. W. STRATTON, Town Clerk; Lynn, Mass., J. C. HASKELL; Peabody, Mass., D. S. LITTLEFIELD, Commissioner; Plymouth, Mass., R. W. BAGNELL; Springfield, Mass., J. C. HANCOCK; Taunton, Mass., G. F. CHACE; Wellesley, Mass., W. H. VAUGHN; Whitman, Mass., J. C. GILBERT; New Brunswick, N. J., C. H. CRAMER; Wilmington, Del., J. A. BOND, Chief Engineer; Baltimore, Md., R. K. MARTIN, Chief Engineer; Atlanta, Ga., W. G. RICHARDS; Nashville, Tenn., GEORGE REYER; Dayton, O., C. E. ROWE, Secretary; Bay City, Mich., E. L. DUNBAR; Springfield, Ill., PETER BERIMAN; La Crosse, Wis., J. E. PARKER, Secretary; Charlottetown, P. E. I., DAVID LAIRD, Chairman Water Commissioners.

—*Underground Waters as Sources of Water Supplies in Ontario.* By PETER H. BRYCE, Secretary Provincial Board of Health, Toronto. 1891. Published by the Board. Pamph., pp. 25.

Mr. BRYCE shows the necessity of recourse to underground water supplies, owing to the rapid denudation of forest lands and the fact that many cities and towns are remote from lakes or ponds available for supply. He then discusses the conditions favorable to underground supplies, and states briefly what has been done to develop such in Ontario. The pamphlet closes with some facts regarding the purity of water from underground sources, chemical analyses of water from lakes, springs and wells being given.

## SOCIETY PROCEEDINGS.

**Boston Society of Civil Engineers**.—At the annual meeting on March 18 the following officers were elected for the ensuing year: President, F. P. Stearns; Vice-President, W. E. McClintock; Secretary, S. E. Tinkham Treasurer, H. Manley; Librarian, F. W. Hodgdon; Director, G. F. Swain. According to the annual report, 35 new members have been admitted during the past year, making the total number 265.

**Liverpool Engineering Society**.—At the meeting on March 4, President Hudleston in the chair, Prof. H. S. Hele Shaw, M. Inst. C. E., read a paper entitled "The Education of an Engineer." He commenced by explaining that, apart from the general importance of the ubject, there was a special reason for its selection at the time, as a committee of the council had been appointed for the purpose of taking steps to insure that such funds as might be devoted by the city council for engineering education under the Technical Instruction act might be applied in a way that would be satisfactory to the society. It was pointed out that the scope of the profession of engineering was so wide as almost to defy definition, though that given by Telford and adopted by the Institution of Civil Engineers, had never been improved upon. A brief statement of the various branches was then given, and the various diverse modes in which a man might become an engineer were illustrated by the early career of Whitwork, Brunel, Vignoles, Bidder, Rennie, Cubitt, Siemens, Bessemer, Fairbairn, Bramah, Maudesley, Ericsson and others. These, though of course exceptional lives, served to show that it would be absurd to attempt to narrow down the channels by which those who had the natural ability should follow their bent and enter the profession.

The question, however, arose, Are there not certain broad lines upon which engineering education might be best carried out? The teaching of the rough school of practical experience was compared with the smoother channels of school and college life. The value of continuing education from books after entering upon the professional career, and especially the influence of societies such as their own, was dwelt upon. The growth of such societies was illustrated by statistics and by curves showing that these facts were recognized. The paper concluded by showing that the effect of experience was to convince each man that, whatever knowledge and skill he acquired, as long as he remained in practice, his education as an engineer would never cease.

**Engineers Club of Philadelphia**.—Meeting of March 7, 1891, 38 members present. Mr. S. L. Kneass, Chairman of the tellers of election, reported that 115 eligible votes, had been cast upon the new Constitution and By-Laws. 108 being in favor thereof, and 7 against.

The Secretary presented for Mr. J. J. Hoops, notes on the Mississippi River Discharge, and for Mr. C. B. Hunt, notes on Street Cleaning in Washington, D. C. There was some discussion by Messrs. E. V. d'Invilliers and Rudolph Hering, and, on motion of Mr. John C. Trautwine, Jr., the subject of Street Cleaning on Asphaltum and other smooth pavements was referred to the Committee of the Board on Information and Entertainment, to report to the Club as to the practice in this matter in various important cities.

The Secretary presented for Mr. Howard Constable, a description of the Re-enforcement of Foundation in a Drawbridge Pier.

Mr. Rudolph Hering continued reading a paper on the Corrosion of Iron and Steel, and referred to galvanic action as a principal cause. He gave the results of experiments on this subject, and principally of those made by Mr. Thos. Andrews, of England. Wrought iron was placed in connection with numerous steels and cast iron, and exposed to sea water for about 300 days. From these it was found that metals corroded much faster when in galvanic connection than otherwise. The wrought iron (Wortley best scrap) resisted corrosion better than either steel or cast iron. The electro-chemical position of the steel changed frequently with reference to wrought iron, indicating that corrosion took place alternately in the wrought iron and steel. The position was almost constant, however, when connecting wrought and cast iron, indicating corrosion to take place almost entirely in the latter. Gravimetrical results were also given, which showed the amount of corrosion in grains per square foot per annum, under the conditions assumed in the experiments.

The question of inserting authors' names in notices together with the titles of their papers was, on motion of Mr. E. V. d'Invilliers, referred to the Information and Entertainment Committee.

HOWARD MURPHY Secretary.

# ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

*Published Weekly at Tribune Building, New York.*

**Vol. XXV. Saturday, March 28, 1891.**

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

**Subscription Rates:** *One Year,* **$5.00;** *6 months,* **$2.50;** *4 months,* **$2.00;** *Single Copies, 12 cents. To all* **Foreign Countries** *in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses.*

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**Advertising rates, 20 cents per line** *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

**Drawings and Photographs** *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*


## COMING TECHNICAL MEETINGS.

***Western Society of Engineers.***—April 1. Secy., J. W. Weston, 230 La Salle St., Chicago.
***Engineers' Club of St. Louis.***—April 1. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.
***American Society of Civil Engineers.***—April 1, "Cable Railways." Annual meeting, May 20, at Lookout Mt., Tenn. Secy., Francis Collingwood, 127 E. 23d St., New York.
***Engineers' Club of Minneapolis.***—April 2. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
***Technical Society of the Pacific Coast.***—April 3. Secy., O. von Geldern, 819 Market St., San Francisco.
***Association of Civil Engineers of Dallas.***—April 3. Secy., E. K. Smoot, 803 Commerce St.
***Northwest Railroad Club.***—April 4. Secy., H. P. Robinson, St. Paul, Minn.
***Engineers' Club of Philadelphia.***—April 4. Secy., Howard Murphy, 1122 Girard St.
***Civil Engineers' Society of St. Paul.***—April 6. Secy., C. L. Annan.
***Civil Engineers' Association of Kansas.***—April 8. Secy., J. C. Herring, Wichita, Kan.
***New England Railroad Club.***—April 8, "Air Brakes for Freight Trains." Secy., F. M. Curtis.
***Engineers' and Architects' Club of Louisville.***—April 8. Secy., G. W. Shaw.
***Northwestern Track and Bridge Association.***—April 10. Secy., D. W. Meeker, St. Paul, Minn.
***Engineers' Club of Duluth.***—April 11. Secy., M. W. Lewis.
***Engineers' Club of Kansas City.***—April 13. Rooms, Baird Building. Secy., H. Goldmark.
***Civil Engineers' Club of Cleveland.***—April 14. Secy., A. H. Porter, 50 Euclid Ave.
***Denver Society of Civil Engineers.***—April 14, "Proper Use of Metal in Bridges." Secy., Geo. H. Angell.
***Engineering Association of the South.***—April 14. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.
***Engineers' Club of Cincinnati.***—April 16. Secy., J. F. Wilson.
***New York Railroad Club.***—April 16. Rooms, Gilsey House. Secy., H. G. Prout.
***Western Railway Club.***—April 21. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.
***Engineers' Society of Western Pennsylvania.***—April 21. Secy., S. M. Wickersham, Pittsburg, Pa.
***Boston Society of Civil Engineers.***—April 22. Secy., S. E. Tinkham.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July–December, 1890), is now in press, and will be issued about April 15, in a separate small volume handsomely bound in cloth, which will be sold at $1. It will prove a valuable work of reference even for those whose files are not complete.

OUR readers will recall that some months ago we published for several weeks in succession a notice asking for any information as to well authenticated instances of actual accidents from car lamps. It brought in a few replies, but only a few, which we shall quote later, in connection with the data as to car-lighting which we expect to give shortly, as heretofore stated. In the mean time, however, we have this very week noticed the following item in the press dispatches, which seems to carry its own moral with it:

ANDERSON, Ind., March 21.—A train of two parlor coaches and a mail, express and baggage car was burned in the Cincinnati, Wabash & Michigan yards here yesterday morning. The train had been made up to go to St. Joseph, Mich., and was due to leave at 6 o'clock. Just before the time to pull out of the yards, a lamp in one of the coaches exploded, and before the flames could be subdued the train was burned. The loss approximates $25,000.

The more immediate moral of such an occurrence is that a properly inspected oil, of high enough test to be suitable for car-lighting, would not have exploded in this manner. But, as even JOVE sometimes sleeps, it also indicates that any system which depends for safety on the constant exercise of an intelligent vigilance, and tends to drop back into dangerous conditions as vigilance is relaxed, is not altogether an ideal system for car-lighting or anything else, and can never be made such. It was one of the shrewdest sayings of Mr. LINCOLN that "You can fool all the people some of the time, and some of the people all the time, but you can't fool all the people all the time." With even more truth we may say you can get a decent caution out of some employees all the time, and out of all employees some of the time, but you can't get it out of all employees all of the time. Any system which ignores this truth and is made dangerous by stupid negligence is to that extent defective, since occasional stupid negligence is an all but universal human frailty, among ignorant and intelligent alike.

OUR readers who are interested in extraordinary meteorological events, or who have occasion to design or manage engineering works in any part of our so-called arid region, especially irrigation works, will but be much interested in the record of "A Remarkable Rainfall" which appears in another column. That, in a valley within 50 miles of a region which is among the driest on the globe, with sometimes only a fraction of an inch rainfall per annum, the clouds should develop a capacity for dropping 13 ins. in 23 hours and 23.4 ins. in 54 hours upon the astonished ground, is a phenomenon which is at least portentous for designers of dams and spillways therefor, and is somewhat of a moral lesson for designers of bridges in all parts of that vast region. It is a lesson which engineers everywhere are somewhat slow to learn that provisions for ordinary storms only are not sufficient, and all the visible surroundings of the arid region make it particularly hard to realize that fact.

A PECULIARLY atrocious case of attempted incendiarism, the last of a series of such attempts for which the week has been noticeable, emphasizes the need for some amendment of the present defective laws in regard to the protection of tenement houses against fire. The building was one of a block of four, five stories high, accommodating 4 families on each floor, or possibly 100 persons in an ordinary city lot, and 400 persons on an area about 100 × 100, which is at the rate (including streets) of about 1,600 per acre, *or* 1,024,000 *per square mile.* No less than 68 persons were sleeping in the building on the night of the fire. The stairs were all of wood and under them a lot of combustible material had been gathered together and set on fire. There was an air shaft between each pair of houses (also wood), furnishing the most perfect kind of a chimney for a fire in the basement and also insuring that the smoke and flame would spread rapidly through every part of two of these buildings at least. The door at the base of this shaft, usually locked (at least, it is claimed after the event that it was), had been opened and locked open by a timber prop. With still more diabolical ingenuity, the inside knobs to the front doors of all four houses had been removed, so that the intended victims could enter the trap from without, but none of them could escape from within. The "fire escapes" consisted simply of balconies connecting the four houses, which would be of little avail to one house at least if two caught fire at once. There were no connecting ladders.

The plot was frustrated only because one of the tenants was bartender in a saloon which was violating the law, and so he did not reach home till 2:30 A. M. He then smelt smoke and his wife insisted on his going down stairs to look into its cause. Otherwise, had all the tenants been in bed and asleep, the entire building would soon have been a furnace from which few could have escaped. Yet the building laws have no provisions to forbid such wooden air shafts and wooden stairways as were the chief source of danger to life in this structure, nor to require even slow burning construction, nor to enforce some approach at least to the caution which is exacted "for buildings over 80 ft. in height" (that is to say, for the tenements of the well-to do), which latter must be strictly fire-proof.

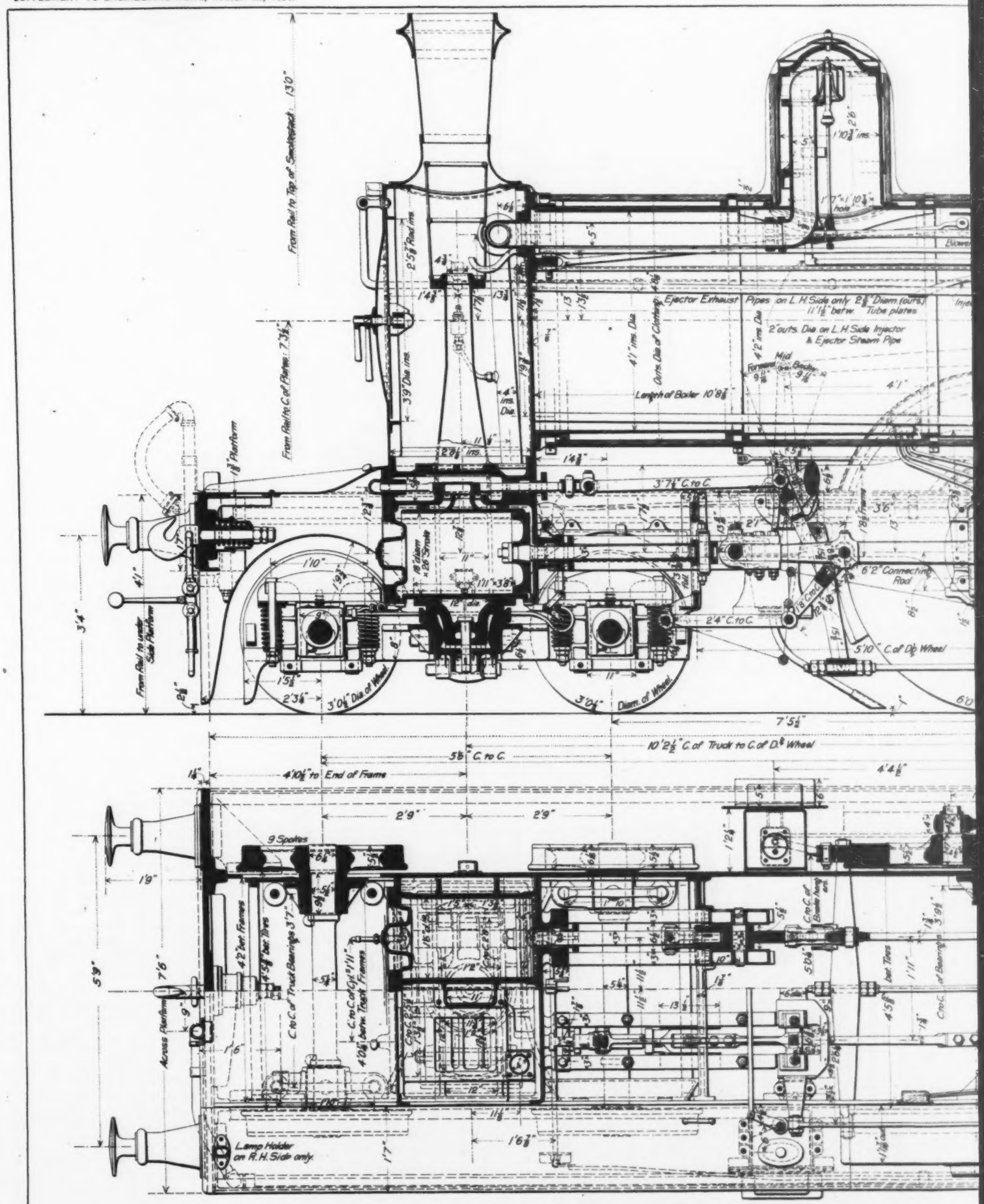
THE occurrence is not likely to have much immediate effect, we fear, because the plotted loss of life did not occur, but surely it ought to serve to impress upon a thoughtless public a truth which it has not yet grasped, that the time cometh and now is when radical modifications of the fire laws are demanded both by humanity and by true economy. However it may have been in the past, nothing but the short-sighted greed of man and the absence of proper fire laws makes it necessary that even the poorest should be housed in combustible homes, or that the business districts in the heart of our great cities should be any longer exposed to the danger of general conflagrations.

Great advances have been made within the last few years in the art of fire-proof construction. Great changes have taken place in the comparative cost of building lumber and of iron, steel, terra cotta and other fire-proof building material. Lumber has gone up, and will continue to do so. Steel and terra cotta and other like materials have gone down, and will continue to do so. There would therefore be no hardship, but great and increasing (if not exactly uniform) gain to all in rigid rules requiring (1) that no building whatever should be erected within a specified business district unless of fire-proof construction, and (2) that no building in the nature of a tenement house, hotel, or other structure tending to endanger many lives should be erected anywhere in the city unless fire-proof. The case as respects tenement houses may be briefly stated as follows:

| | Cost per cu. ft. |
|---|---|
| Cost of large brick tenements of cheapest construction | 12 to 15 cts. |
| The same building built fire-proof throughout, but plainly | 20 to 25 cts. |
| Larger but finely built and finished office buildings | *23 to 40 cts |

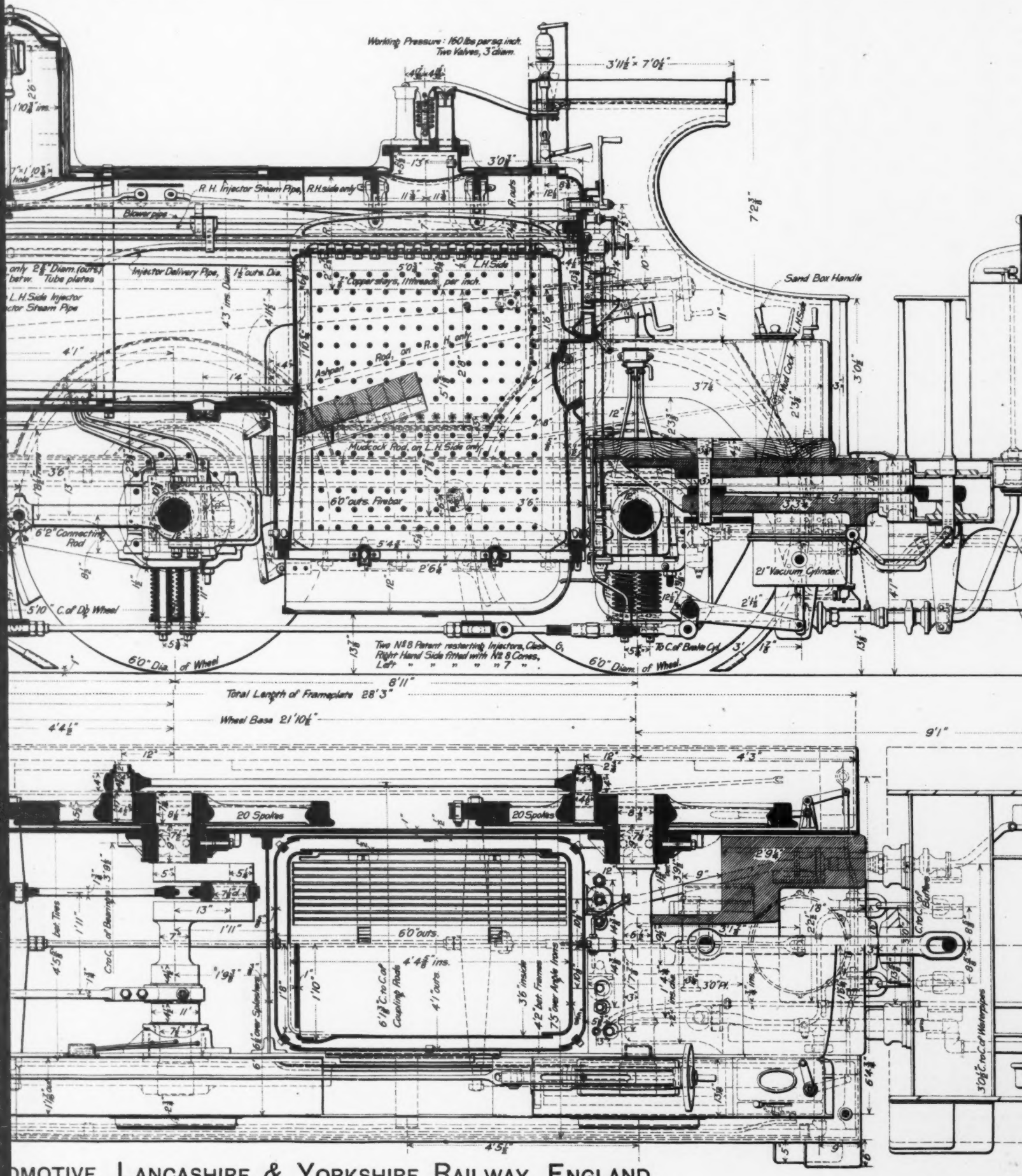
Some very elaborate office buildings, like the Equitable, have cost more than 40 cts. per cu. ft., but we are informed that all of the magnificent Chicago office buildings of recent construction have cost less. Be this as it may, the ground rent for a tenement block is no higher for one class of building than another, the stories are seldom so high as 11 ft., and the reasonable rent per sq. ft. of floor, consequently, could rarely be increased by more than, say, 8 per cent., or $0.88 to $1.10 per sq. ft., or 7 to 9 cts. per year. At this

*One very large and handsome Chicago office building only cost this sum per cubic foot.


From Rail to Top of Smokestack 13'0"
From Rail to C of Plates 7'3½"
Ejector Exhaust Pipes on L.H. Side only 2⅜" Diam (outs.) 11 1⅛" betw. Tube plates
2" outs. Dia on L.H. Side Injector & Ejector Steam Pipe
Length of Boiler 10'8⅞"
3'7½" C. to C.
2'4" C. to C.
6'2" Connecting Rod
5'10" C. of Dr. Wheel
7'5½"
10'2½" C. of Truck to C. of D.r Wheel
5'5" C. to C.
4'10½" to End of Frame
9 Spokes
Lamp Holder on R.H. Side only.

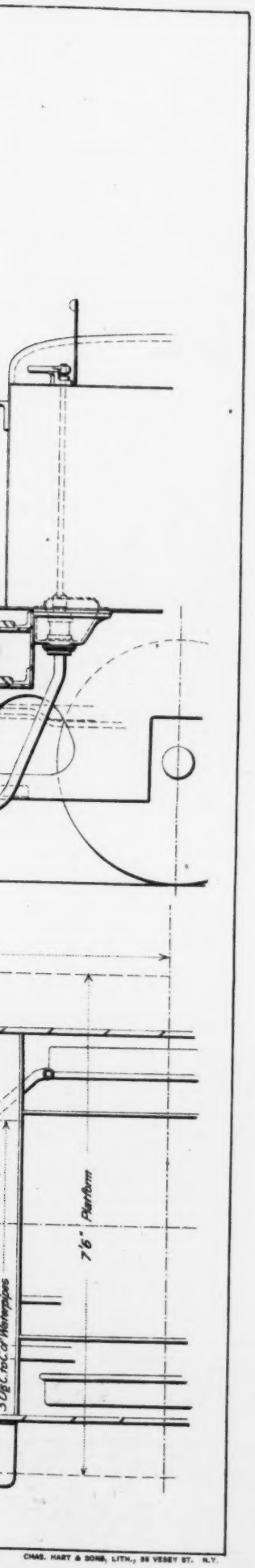
# EXPRESS PASSENGER LOCOMOTIVE, LA

J. A. F. ASPINAL


Working Pressure: 160 lbs per sq. inch.
Two Valves, 3" diam.
3'11½" × 7'0½"
3'0½"
R. H. Injector Steam Pipe, R.H. side only
Blower pipe
Injector Delivery Pipe, 1½" outs. Dia.
L.H. Side
Sand Box Handle
Mud Cock
Ashpan
Rod, on R. H. only
Mudcock Rod, on L.H. Side only
6'0" outs. Firebar
6'2" Connecting Rod
5'10" C. of Dr. Wheel
21" Vacuum Cylinder
Two No. 8 Patent restarting Injectors, Class G,
Right Hand Side fitted with No. 8 Cones,
Left " " " " " 7 " .
To C. of Brake Cyl.
6'0" Dia. of Wheel
6'0" Diam. of Wheel.
Total Length of Frameplate 28'3"
Wheel Base 21'10½"
20 Spokes
20 Spokes
6'0" outs.
4'4⅞" ins.
4'5½"

# OMOTIVE, LANCASHIRE & YORKSHIRE RAILWAY, ENGLAND.

J. A. F. ASPINALL, CHIEF MECHANICAL ENGINEER.




CHAS. HART & SONS, LITH., 98 VESEY ST. N.Y.

rate; a cheap tenement apartment, occupying one-fourth of a 25-ft. building, or say 500 sq. ft. of floor would cost $35 to $45 per year, or $3 to $4 per month; more in a fire-proof building than in a fire-trap. A large part of this difference would be offset by diminished cost of insurance and repairs, not to speak of the great sanitary gain, which would alone be cheap at the increased cost.

## The Present Status of the Introduction of M. C. B. Automatic Car-Couplers.

We have received from the Hon. L. S. COFFIN, ex-Railroad Commissioner of Iowa, whose earnest, unselfish and persistent efforts in favor of the introduction of automatic couplers and train brakes have made him well-known to most of our readers, a long and earnest letter under the appealing headline of "Come, Let Us Reason Together," in which that gentleman betrays the fact that even he is not aware of the very great progress in the adoption of M. C. B. automatic couplers for freight cars which has been made within the past few months. Consequently, he has still some fear that the M. C. B. standard type of coupler may not go into universal use after all, or so slowly as to neutralize many of its advantages; and he therefore repeats in some detail and with renewed force and earnestness the arguments which he and others were advancing with a necessary and effective energy three or four years ago.

We do not publish his letter, simply because information which has been until this issue in our exclusive possession, and which we have but recently gathered, shows that his fears are wholly unnecessary: that the movement has advanced far beyond the experimental or doubtful stage: that the entire opposition which can be said to be effective is confined to a few narrow-minded cranks holding influential offices in New England, who are keeping that section far in the rear of this procession, a place which it has held in a number of other processions of the same general character.

Our information has been gathered to serve as the basis of a new map, showing the status of the introduction of automatic freight couplers and train brakes, similar to that which we published Dec. 21, 1889, or a little over a year ago. This map we shall publish in our issue of April 25, 1891, and until then the figures cannot be regarded as absolutely complete, but the errors are chiefly those of omission, and the possible corrections can have but an insignificant effect upon the aggregates. For some reasons we should have preferred to hold these records until they could have appeared in detail with the map: but when even so well informed and deeply interested a man as Mr. COFFIN is found to be so seriously at fault in his knowledge of the existing situation, and when some of the various State Railroad Commissions are afflicted by a like misunderstanding, as some recent occurrences indicate that they are, it appears to us to be for the public good that the main facts as to the existing situation should be at once made known, leaving the precise figures to follow later with the map. In a few words, these facts are as follows:

*Railway companies controlling over* **72,000** *miles of road and over* **700,000** *cars have adopted the policy of applying automatic couplers of the Master Car Builders' type to new freight cars, and over* **99,000** *cars were equipped with these couplers on Jan. 1, 1891.*

In December, 1889, our returns from railway companies showed that the policy as above stated had been adopted by companies controlling 35,885 miles of road only, and that the total number of cars equipped was 47,174. Even then the showing was an impressive one, as will be seen by referring to our map above referred to.

Moreover, even these figures do not fully show the rapid progress which the M. C. B. coupler has made, not the firm position in railway service which it now holds. Some of the companies whose mileage and cars are included in the above totals are applying the coupler to all new cars, others to all new cars of certain classes. The figures for each class are as follows:

| | On Jan. 1, 1891. Mileage. | Cars. | In Dec., 1889. Mileage. |
|---|---|---|---|
| Mileage and cars controlled by companies applying M. C. B. couplers to *all new cars*..... | 51,110 | 567,433 | 19,565 |
| Mileage and cars controlled by companies applying M. C. B. couplers to *all new cars of special classes*..... | 18,585 | 139,010 | 16,320 |
| Totals..... | 72,595 | 702,443 | 35,885 |

The increase is thus seen to be almost wholly in the class of roads which apply it to *all new cars*. Of these companies a very large proportion also report to us that they are applying M. C. B. couplers to all cars coming into the shop for general repairs. Almost all the companies which are now applying the coupler to special classes of cars report that they are applying it to all new box or covered cars, which includes, of course, a large proportion of the total freight rolling stock.

It should be again especially noted that any errors in the above figures are probably errors of omission. The totals above given include only those companies which sent us reports of the existence of *a definite policy* with regard to the equipment of new freight cars with M. C. B. couplers. There are other roads which reported to us the use of the couplers, in some cases to a considerable extent, but stated no definite policy with regard to their use. Among these are the Atchison, Topeka and Santa Fe, controlling 7,122 miles of railway and 25,515 cars. In December, 1889, they reported to us that all new cars were to be equipped with M. C. B. couplers. An unfortunate choice in the make of M. C. B. coupler to be used (the old Dowling coupler, which has since been materially improved and is now much liked by some influential companies) combined with the serious financial straits in which the company has been, are, we suppose, the reasons for the abandonment of this policy; and though the company has now about 1,000 cars equipped, it is not included in the above totals for this year, though it is included in the total for last year.

There are also a few roads on which we know M. C. B. couplers to be in use, from which no returns have yet been received, and reports from them may slightly swell the above totals.

It will hardly be denied, however, that the figures as they stand are significant enough. Taking the total extent of railway in the United States as 167,400 miles, and the total freight rolling stock as 1,150,000 cars, it appears that companies controlling *over* 43 *per cent. of the mileage and over* 61 *per cent. of the freight cars* have definitely adopted the policy of applying M. C. B. automatic couplers to new cars. Note that the proportion of cars controlled by these companies is much greater than the proportion of miles controlled. This indicates, what we shall shortly show by publication of the reports from each company, that the roads which have adopted the M. C. B. coupler are the great systems, those carrying a heavy traffic and (most important figure of all in this connection, controlling the bulk of the freight rolling stock. These are the roads whose mechanical affairs are managed with greatest intelligence and progressiveness, and their example in mechanical matters, wherever interchangeability is an essential, is sure to be followed, sooner or later, by the smaller and less important railways all over the country.

But it may well be asked, Why should the other railways of the country still be delaying this reform? Certainly the statistics of the progress of the M. C. B. automatic coupler published by this journal in December, 1889, and briefly summarized above, were sufficient to convince any fair-minded man that the type of automatic coupler selected by the Master Car-Builders' Association was so rapidly growing in favor as to leave no doubt of its ultimate and early universal adoption. A partial explanation as to some of these dilatory ones may be readily found.

Of the companies controlling the 94,805 miles not included in the above totals, those controlling about 20,000 miles, according to reports to us, have M. C. B. couplers more or less in use. Some of them use them quite largely, although they report no definite policy in the matter; others have begun in a very small way, as, for instance, the Southern Pacific Ry., which, with nearly 4,300 miles controlled, has only 10 cars equipped with M. C. B. couplers, and those of a make unheard of on any other road. Then there are the New England roads, aggregating all told less than 7,000 miles, which, for reasons best known to themselves, maintain an altitude of virulent hostility to the M. C. B. coupler, of which we have found not a trace in any other part of the country, with the single exception of the Lake Erie & Western R. R.

All the remaining companies, controlling all told about 67,000 miles, are, so far as we can learn, not especially opposed to the coupler, and their backwardness in the reform is probably due in part to poverty, in part to mere inertia, and in part to pure ignorance of what the rest of the world is doing. Perhaps the most prominent among these roads are the lines controlled by Mr. JAY GOULD, which, with the exception of the Union Pacific (whose coupler policy was adopted before that eminent financier secured its control) are doing nothing. There are a few other important companies which have done nothing; but a large proportion of the 62,000 miles above is made up of the smaller local roads, which will eventually follow the example of the majority if they are not absorbed by some large system before they decide to move. These facts our map, when published, will make clear to the eye by mere inspection.

The enormous importance of the adoption of automatic freight-car couplers from a humanitarian standpoint is so well understood that we need only mention it. In this connection, however, we cannot help giving a few figures as to the corresponding returns which we have collected concerning the use of the Westinghouse automatic brakes on freight cars, since that reform is of equal or greater importance than the introduction of automatic couplers for lessening fatalities among railway brakemen.

Briefly, the reports to us show that the air brake has advanced quite as far as the automatic coupler. Companies controlling **87,915** *miles of railway and* **698,375** *cars* report the adoption of the policy of equipping new cars with the Westinghouse automatic brake.

The mileage and the cars controlled by the companies equipping all new cars, and by those equipping all new cars of special classes, are shown in the following table, and the figures are compared with those for 1889:

| | On Jan. 1, 1891. Mileage. | Cars. | In Dec., 1889. Mileage. |
|---|---|---|---|
| Mileage and cars controlled by companies applying Westinghouse brakes to *all new freight cars*.... | 50,276 | 274,821 | 26,551 |
| Mileage and cars controlled by companies applying Westinghouse brakes to *all new freight cars of special classes*..... | 37,639 | 423,554 | 21,109 |
| Totals..... | 87,915 | 698,375 | 47,640 |

The total number of freight cars in the United States equipped with the Westinghouse automatic brake on Jan. 1, 1891, was almost exactly 150,000. In December, 1889, the number was about 100,000.

Thus it will be seen that these two great reforms ("useless each without the other" to a large extent are not simply marching on to early victory with nearly equal steps, but have already won victory, because it is not possible for incorrigible obstructionists to hold out indefinitely with freight cars as it was with passenger cars. In respect to the

latter, the policy of one road matters little to the others even now; and it mattered still less when automatic passenger brakes and couplers were first introduced, so that any road could, and many great roads did, hold out against one or the other for years after it was clear that their enforced surrender was only a question of time. But freight cars go everywhere,and must be acceptable everywhere. Isolated inaction, therefore, will be resisted by a strong and constant pressure, backed by a possible refusal of interchange privileges as well as possible legislation by Congress and the states.

In view of these facts, it is clearly quite superfluous to publish arguments as to the wisdom of sticking to the action so far had, on humanitarian or any other grounds, even from so earnest and well-informed a man as Mr. COFFIN. He has been mistaken as to the facts of the situation. Supposing it be true, as he says it is, that "the minority intends to seek to rescind the action of the M. C. B. Association on this matter at the coming M. C. B. Convention at Cape May;" even if the handful of members who constitute the active minority now intend to do this they will not, for to do it would make themselves the laughing stock of the convention. The day of doubt as to what will be done is past. The only remaining question is: How fast will it be done?

### Bacteriological vs. Chemical Analysis of Sewage-Polluted Waters.

In connection with the water carriage of sewage, it is a fact well understood for some years by engineers that the old chemical analysis, so long depended upon as a test of the comparative purity of water liable to sewage contamination, fails to detect bacteria, and is apt to disarm suspicion in cases where the later bacteriological tests show good cause for alarm. This advance in the analysis of water to be used for domestic consumption is, however, not as fully and generally appreciated as it should be, and the following practical case from the experience of the authorities of Zurich is of value in this connection:

The sewage of Zurich is discharged into the Limmat, and as far back as June, 1881, complaint was made regarding the pollution of this stream. In March, 1881, the total flow of water in the Limmat was about 27,500 galls. per second, and the estimated volume of sewage was 88 galls. per second. Samples of the water in the river were taken, about 170 ft. below the sewer outfall, and found to come well within the stipulated degree of purity as tested by permanganate of potash. Gagings made showed that the proportions of sewage in the river water varied from 1 in 101, in November, to 1 in 161, in February.

The chemical tests were so satisfactory that the new sewerage works of Zurich, completed in 1883, had their outfall carried to midstream without further precautions. Complaints made of increased pollution gave rise to further chemical tests in 1886-87, with the result that only in one case did the contaminated water require more than the 60 parts in one million of permanganate stipulated for in the standard of purity fixed by the authorities. As the complaints continued, Prof. WYSS was instructed to report on the subject and pay especial attention to bacteriological tests. This latter analysis was conducted by Mr. CARL SCHLATTER, who describes his experience in the *Zeitschrift fuer Hygiene*, vol. ix., p. 56, translated in part in the "Abstracts of the Institution of Civil Engineers," vol. ciii.

Mr. SCHLATTER describes the Limmat as flowing from the lake, in a straight course, through Zurich with an average volume of about 21,000,000 galls. per day. The main sewage outfall is at Wipkingen, and altogether a population of about 67,000 persons assist in fouling the water passing into the Limmat. The dry-weather flow of sewage amounted to from 4,000,000 to 5,300,000 galls. per day. Below Wipkingen there are no considerable affluents and no factories or villages of importance.

Test samples were taken from ten points scattered over 8.7 miles of the streams, beginning below the town, where the water was still unmixed with sewage, and ending at a point far below the outfall. All samples were taken in mid-stream, and at intervals of a fortnight, between January and May, 1889. The specimens were examined within 1½ hours, as a maximum, after collecting, and all precautions taken to obtain cultures absolutely free from foreign germs.

The methods and results are fully described and set out in tabular form in the original paper embodying the results of 40 tests, and showing temperature, water level, current velocity, etc. These tables show that the number of germs in the water of the Lake of Zurich fluctuate but little, and vary from 100 to 200 per cu. centimeter. In passing through the town the water of the Limmat becomes at once much polluted, but as soon as the sewage is mingled with it the rise in the number of germs is astonishing. The river water, which showed from 1,000 to 2,000 germs, from simply flowing through the town, is at once found to contain 500,000 germs to the cubic centimetre of sewage-mixed water. After the outfall is passed the number of germs diminishes as the distance from this outfall increases, until six miles below this outfall the river water becomes, at times, as pure as it was above the town. Mr. SCHLATTER says the more rapid the current, the smaller the relative improvement; and he thinks that the purifying action is rather one of deposition than of the chemical influence of oxygen, etc., as has been often supposed.

While the investigations of the author here quoted show conclusively the effect of sewage in multiplying the germs in water so contaminated, he fails to note the extent to which these germs are injurious to public health. Bacteriological research dates, practically, from 1885, when Dr. KOCH explained his methods before the Berlin Cholera Conference of that year; and, while remarkable discoveries have been made or claimed, the science may be said to be yet lacking in systematic record of distribution, and exact classification into harmless and injurious organisms. We do know, however, that all known infectious matters are of the nature of micro-organisms, and that certain bacilli, emanating from man and beasts, are exceedingly dangerous when introduced into a water supply. The known presence, therefore, of a multitude of even unclassified germs in this supply is sufficient cause for the gravest suspicion, and good reason in itself for changing the conditions producing them whenever possible.

## CORRESPONDENCE.

### The East Orange Sewage Disposal Works.

NEW YORK, March 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your abstract of the report on the Sewage Disposal Works of East Orange you note that 30,000 galls. of water are discharged daily by 21 flush tanks. This would be nearly 1,500 galls. a day for each tank, which with tanks of the ordinary capacity of 200 galls. would require 7 discharges a day; or a discharge once in 3½ hours. Is there not some error in the number of tanks quoted? If I remember correctly there were about 50 tanks constructed. ALBERT L. WEBSTER.

[The statements as made and quoted are correct. The article distinctly states that the tanks discharge once in 3½ hours. Our records show that there are 45 tanks connected with the system, only 21 of which were in operation when the report was made.—ED. ENG. NEWS.

### Temporary Support of Trestles in Floods.

MIDDLESBURG, Ky., March 16, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: As it is often necessary to place a temporary support under a trestle during high water in a swift current, so that a train may pass over, I will describe a plan used successfully a few days ago, for the benefit of those who may have it to perform.

Take two post timbers long enough to reach bottom and extend 2 to 3 ft. above the track; spike or bolt a heavy crosspiece near the top, spacing the posts just wide enough to clear the ends of the ties; lower the other ends until a cross timber can be run under the stringers above them; spike this piece about 15 ins. from the ends, with due allowance for irregularities of the bottom. Secure the upper end loosely with rope to the ties at the place wanted; fasten a rope to lower crosspiece long enough to let it reach bottom, but not swing completely over. Drop the lower end to place, fasten the timbers close under the stringers, and with wedges press to a firm footing. Brace to track or stringers, and saw the posts off level with the track. W. H. DORSEY,

Asst. Engr., M. T. Co.

### Torpedoes in the Fourth Avenue and Hoosac Tunnels.

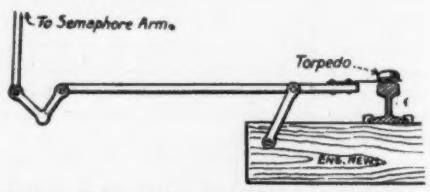
NORTH ADAMS, Mass., March 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Concerning the late accident in the Fourth Ave. tunnel, it may be of interest to know that a torpedo device is in use at the Hoosac tunnel which is cheap, convenient and effective.

Its essential parts are three pieces of half-inch gas pipe, a thin piece of sheet iron and a supply of torpedoes. The same thing, substantially, is in use on the railway that runs around the city of Paris.

The first one made in this country, so far as I know, was put in use by the writer at the east end of the tunnel in June, 1884, and it is still there in good working order, and is reported never to have failed to do duty in the seven years it has been in use. It is made as shown in the accompanying sketch.




Sketch of Torpedo Device used in Hoosac Tunnel.

Inside of the Hoosac tunnel no signals but torpedoes were ever depended on. Lights of all kinds were experimented with and found unreliable, but they were found unreliable because they could not be seen with any certainty through the thick smoke and steam, and not for the reason given in ENGINEERING NEWS of March 7, that a probable cause of the New York accident was the effect of the smoke in changing the color of the light.

A. W. LOCKE.

[Another and more elaborate torpedo appliance than that shown, but serving the same purpose in substantially the same way, is in extensive use, and has the advantage that when one torpedo is exploded another automatically takes its place. We would remind our correspondent, however, that the operating conditions are very different at the Hoosac and Fourth Ave. tunnels. If 400 or 500 trains a day were passing through the Hoosac it would be impossible to place the primary and sole reliance on torpedoes as signals, for the reason that they would be continually exploding; and for crowded traffic some form of visual signal seems the proper one if supplemented by some emphatic warning like a torpedo in case they are disregarded. As for the reasons why lights should occasionally deceive, it does not follow that because lights were rejected on the Hoosac for one reason, that they may not deceive when used for another reason. Do we understand our correspondent to question or deny that a so-called "white" (*i. e.*, yellow) light seen through dense smoke appears red?—ED. ENG. NEWS.]

### Some Track Conundrums.

BROOKLYN, N. Y., March 11, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Can you put me on the way of getting information on the following points? I have consulted your valuable paper for months without success:

1. What are the requirements of a perfect rail joint?
2. What is the annual cost for new bolts, washers, etc., per mile of track?
3. What is the annual cost per mile of track for inspection or "track-walkers"?
4. Is this "track-walking" necessitated chiefly by the need of tightening bolts on rail joints, or would it be equally necessary were the rail joint rendered perfectly secure?

I trust you can favor me with some information on above subjects, and your courtesy to your other readers leads me to hope I may be equally fortunate. T. B. R.

[1. The only perfect joint is no joint at all, from which it follows that there never can be such a thing. The one which approaches nearest to it is of course the best, but as to which joint that is, opinions differ, and are likely to continue to do so.

2. It is incapable of precise estimation, and varies almost directly with the cost of rails, and hence with traffic. The usual rule is to renew the bolts, washers, etc., with the rails. The total weights may be summarized as follows:

| | Gross tons. |
|---|---|
| Rails, 60-lb. | 94.3 |
| Joints, say, 352, @40 lbs. each | 6.3 |
| Bolts, say, 1,408, @1¼ lbs. | 0.8 |
| Spike, 4 per tie, 11,264 = 31⅔ kegs. | 2.75 |

Comparing these quantities with any price-list a reasonably close approach can be made to the *ratio* of the cost of these items to the cost of rails. Maintenance of rails ought not to cost more than ½ ct. to 1 ct. per train mile, but as a matter of fact it generally shows up at 2 to 3 cts. per train mile, in part because the process of renewing side tracks and branches with steel is not yet completed, perhaps.

3. Track-walking costs $50 per mile per year as a minimum, with about $5 per mile for each extra train per day (round trip) over three or four, up to a maximum of $150 to $200 per mile, beyond which this account rarely runs. A few important roads opened somewhat more than this.

4. In the main, the amount of track-walking done is independent of the amount of work to be done in tightening bolts. In cases there would be a saving if this work had not to be done, but, in the main, curtailment of track-walking would not be justified, even if there were no bolts to tighten. Some roads do not permit the track-walkers proper to touch the bolts unless they see something wrong.—ED. ENG. NEWS.]

## The Rate of Ebullition in Steam Boilers.

NEW YORK, March 21, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In reading your article on the "Staybolt Problem" in ENGINEERING NEWS of March 21, I notice you speak of the "violent ebullition" in the water space around a furnace, and state that the water in the space about the firebox must be a mass of seething foam, etc. Is there any direct evidence that such is the condition of the water in the boiler, even in those parts of it directly in contact with the firebox heating surface? I am aware that such is the usual view, but I do not know that there is any direct evidence on the subject. The experiments which you allude to, made on the Lake Shore & Michigan Southern R. R., in which a pipe was placed with its opening within ½ in. of the furnace sheet and led outside the boiler, appeared to me not to be conclusive, for the reason that the water in the boiler being under a pressure of from 100 to 180 lbs. it necessarily turns into steam the instant it reaches the atmosphere, and the fact that no solid water was drawn from these pipes does not appear to me to be conclusive evidence that there was no water in contact with the furnace sheets. When a boiler is blown out no water ever emerges from the blow-off cock, although placed in the bottom part of the front leg of the firebox, and the pressure rarely exceeding 30 to 40 lbs. There is no doubt that while within the firebox it is water, but it becomes steam instantly upon being relieved of the pressure.

It has occurred to me that the generally accepted theory of violent ebullition going on in the boiler must be more or less at variance with the facts. There is doubtless rapid circulation going on in which currents of water of different temperatures pass up and down in the boiler, but it is entirely as water, not mixed with steam. I fancy the only ebullition or boiling that takes place is directly under the opening of the steam pipe or throttle, where the pressure is locally reduced, the steam being given off from the surface of the rest of the water quietly and without bubbling. The water in the glass water gage of the boiler certainly shows no signs of "violent ebullition," although, if broken, it is steam which issues and not hot water. GEORGE C. THAYER.

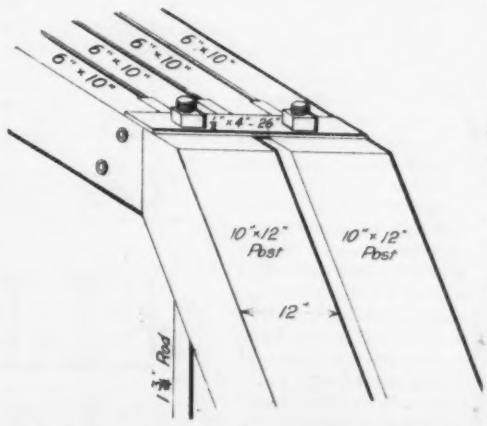
[We will answer our correspondent's first query by asking another. If the Lake Shore & Michigan Southern R. R. experiments are not conclusive, how does an engineer tell by his try-cocks the height of water in the boiler, and whether it is "foaming" or not? To the inexperienced observer the water drawn from the lower try-cock, which is below the water level, may look like steam, but on comparing the flow with that from the upper try-cock, drawing from the steam space, the difference may be easily seen. The mixed steam and water which comes from the steam space when a boiler foams is also easily recognized. Our correspondent is mistaken in supposing that all the water in a boiler flashes into steam when relieved of pressure. A portion of it does turn to steam, but the heat absorbed by its evaporation cools the rest below the boiling point. The percentage evaporated may be readily calculated. A pound of water in a steam boiler at 180 lbs. pressure has a temperature of 379.7° Fahr., and the total heat which it has absorbed in rising to that temperature from 212° (the boiling point) is 172 H. U. The number of heat units required to evaporate one pound of water at atmospheric pressure is 965.2; hence the heat in a pound of water at a temperature of 379.7 Fahr. (corresponding to 180 lbs. gage pressure) will evaporate 172 ÷ 965.2 = 17.8% of the water, leaving the remainder at a temperature of 212°. It is quite true that the proportion of water vaporized in a steam boiler explosion or in drawing from a blow-off cock appears much greater than this. This is due to the fact that when the water is suddenly released from pressure, steam is instantly formed all through the mass of the water, and a large part of the water is dissipated as spray and vapor besides that actually evaporated. It is because of this that in a boiler explosion the water in the boiler generally disappears as well as the boiler. Just why our correspondent supposes the steam in a hard-worked boiler to be given off quietly and without bubbling except just beneath the throttle is not apparent. A glance at a tea kettle will convince him that bubbles of steam form at the heating surface and move upward through the water. Why should boiling go on at an enormously higher rate in a boiler, and steam be formed only at the surface of the water? As a matter of fact there is quite violent ebullition. The glass water gage merely shows the height of the water in the boiler, not what is going on inside.—ED. ENG. NEWS.]

## A Poor Highway Bridge.

PENDLETON, Ore., Jan. 19, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I inclose a small sketch showing connection between upper chord and end post as recently applied in the construction at this place of a bridge across the Umatilla River. The structure is a highway bridge, consisting of two 140-ft. spans, 18 ft. wide in the clear, and I should judge about 16 ft. in height, each truss having 14 panels. The thrust of the end posts, as might be expected, has already forced the vertical rods into the packing keys sufficiently to bend the rods quite a little from the verti




cal, and consequently moved the gib plate until not more than 1½ ins. of bearing remains on the post. It is, perhaps, unnecessary for me to add that the county commissioners are implicated, the bridge being built jointly by them and by certain private individuals. Of course, it is considered a splendid structure by them. The work was *engineered* by a bridge carpenter, who has lately built several similar structures for the county.

I send this, thinking it might perhaps prove of interest to those of your readers who *admire* the average commissioner's idea of good construction. A. L. ADAMS.

## An Easy Method of Drawing Parabolas.

PENCOYD, PA., March 20, 1890.

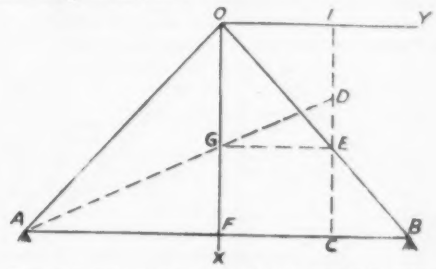
TO THE EDITOR OF ENGINEERING NEWS:

SIR: In bridge calculations by graphic methods, the bending moments developed under uniformly distributed load, or under moving ones are represented by parabolas. I want to describe a very simple way of constructing such parabolas.

Let $OF$ be the maximum bending moment of a beam $AB$ uniformly loaded and resting freely at its ends. It is known that, in this case, the equation of the bending moment is represented by a parabola passing through the three points $A$, $O$, $B$.

Draw the lines $O\,A$ and $O\,B$.

To find the bending moment at the point $C$, for instance, draw a vertical $C\,E$; at $E$ draw a parallel $E\,G$ to $A\,B$. The intersection of $A\,G$ and $C\,E$ in $D$ gives the line $C\,D$ as bending moment in $C$.




That is to say, $D$ is a point of the parabola passing through $A$, $O$, $B$.

Take $O\,X$ and $O\,Y$ as axes. Triangles $A\,D\,C$ and $G\,D\,E$ are similar and give $G\,E : A\,C = D\,E : D\,C$.

If we represent $A\,B$ by $l$ and $O\,F$ by $a$, the above equation becomes:

$$\frac{y}{y + \frac{1}{2}\,l} = \frac{D\,E}{a - x}. \qquad (1)$$

Triangles $E\,O\,I$ and $B\,O\,F$ give also: $I\,E : O\,F = O\,I : B\,F$.

That equation becomes

$$\frac{D\,E + x}{a} = \frac{Y}{\frac{1}{2}\,l} \qquad (2)$$

Equation (1) gives

$$D\,E = \frac{Y\,(a - x)}{Y + \frac{1}{2}\,l}$$

Putting this value of $D\,E$ in equation (2) and solving, we find

$$Y^2 = \frac{1}{4}\,\frac{l^2}{a}\,x \qquad (3)$$

an equation similar to $y^2 = 2\,p\,x$, the general equation of the parabola.

The point $D$ consequently belongs to the parabola passing by $A$, $O$, $B$, for if we make $y = \frac{l}{2}$ in equation (3) we have then $x = a$; also, if we make in equation (3) $x = o$, we find $y = o$. AVILA GRAVELLE, C. E.

## The New Am. Soc. C. E. Constitution.

WEST NEWTON, Mass., March 21, 1891

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Might I ask you to inform me as to the following facts concerning the new constitution of the Amer. Soc. C. E.?

1. Will employment as *instructor* in civil engineering in a university of as high standing as Lehigh count as so much experience?

2. What are the requirements for the intermediate grade of Associate Member?

3. What are the requirements for Junior Member?

4. Will the present members be regraded to suit the new requirements of the constitution?

I would like to know to what class I would now belong, or could shortly aspire. S. W. F., Box 566.

["The performance of the duties of a professor of engineering in a technical school of a high grade shall be taken as an equivalent to an equal number of years of actual practice." An instructor or assistant professor should apparently be considered as "performing the duties" of professor, and the wording would seem to forbid restricting the benefits of the section to those having the title of professor, but the "actual practice" specified does not mean responsible charge of work, of which the candidate for Member must have had five years (with 10 years' active practice and 30 years of age), and for Associate Member, one year, "as principal or assistant," with six years' active practice and 25 years of age. The Junior need be only 18 years, with two years' practice, and an intention to become an engineer, or graduation from a school of engineering being made equivalent to two years' practice in all grades. The Junior must be promoted or drop out at the age 30.

The vested rights of existing members are not affected by the new provisions; there is no regrading. Our correspondent is at present only eligible as Junior. Four years after his graduation, if he continues in active practice, and for one year is an assistant in charge of work, he will be constitutionally eligible as Associate Member.—ED. ENG. NEWS.]

## Notes On English Railways.

(*Continued from p 274.*)

LANCASHIRE & YORKSHIRE RAILWAY.

This line runs across the island, connecting ports on the east and west coast with an extensive manufacturing district, and there is consequently a very large freight traffic. The system has a total length of about 675 miles. The principal cities served are Liverpool, Manchester, York, Preston, Bolton Wigan, Leeds, Huddersfield, Sheffield and Hull.

*Track.*—The standard type of track on this road, as on most other English railways, consists of bull head steel rails, weighing from 80 to 90 lbs. per yd., carried in cast-iron chairs weighing from 28 to 56 lbs., each, which are fastened to creosoted ties 9 ft. × 10 ins. × 5 ins. by various combinations of spikes, trenails and screws. The spacing of the joint ties is usually closer than that of the intermediate ties; but the London & Northwestern Ry. has adopted a uniform spacing of 3 ft. c. to c. On some roads the spacing increases gradually from the joint to the middle of the rail. This road has 86-lb. rails carried in 56-lb. chairs. The latter are unusually heavy, and are secured to the ties by a spike and a trenail on each side of the rail. The joint ties are spaced 24 ins. c. to c. and the intermediate ties 33½ and 34½ ins. c. to c. The wooden keys are on the outside of the rails. The rails are laid with square, suspended joints, spliced by plain splice bars 18 ins. long, and 4 bolts with lock nuts. The nuts and washers are in some places on the inner side, and in other places on the outer side of the rails. The ballast is of cinders, packed up to the level of the tops of the ties, and laid on a foundation of rough stone pitching. Flange or T-rails, weighing 72 lbs. per yd., are used at engine pits, etc. The company has its own plant for creosoting the ties and for boring the holes and attaching the chairs by machinery. The switch rods are made of light channel irons.

There are some very heavy grades on the main line. Through Bolton the line runs in a deep cutting, with brick retaining walls, and having a bridge at every street. The roof of the newer part of the Victoria Station at Manchester, which was built about seven years ago by Mr. WM. HUNT, Chief Engineer, has the roof trusses parallel with the tracks. The apex of each ridge is open, being protected by a covering which projects beyond the opening. No louvres are used. This arrangement has been found to facilitate ventilation, the steam and smoke from the engines passing out very quickly.

*Locomotives.*—This road has about 1,050 engines. The engine mileage is very considerable, being about 15,000,000 miles for the first half of 1890, as compared with a train (remunerative) mileage of 8,225,000 miles. One of the standard types of passenger engines of the eight-wheel type is shown in Fig. 24, and is illustrated and described in full elsewhere, its detail dimensions being given in a table with those of some American engines of the same type. The standard freight engines, shown in Fig. 25, are of the type almost universally adopted on English railways, having 6 wheels, all coupled. Some fine double-end tank engines, built at the company's works in 1890, are of the type shown in Fig. 18 (p. 242), having inside cylinders, 4 coupled wheels and a single pair of leading and trailing wheels on radial axles. The distance from the coupled axles to the radial axles is 7 ft. 10⅛ ins. The side tanks are extended so as to partly inclose the footplate, which is roofed in by an iron cab. Two other types of tank engines are shown in Figs. 26 and 27. The former has cylinders 17½ × 26 ins., 6 coupled wheels 5 ft. 1 in. diameter, and a single pair of 43½-in. trailing wheels on a radial axle. The latter has cylinders 17½ × 26 ins., 4 coupled wheels 5 ft. 8 ins. diameter, and a four-wheel trailing truck with 36-in. wheels. The following table gives the comparative dimensions of passenger, freight and tank engines. The fireboxes of the three classes are 72 ins. long, 49 ins. wide and 70 ins. high, outside dimensions, and have a grate area of 18.75 sq. ft.

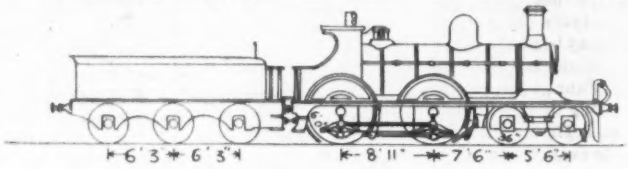



Fig. 24. Eight-wheel Passenger Engine

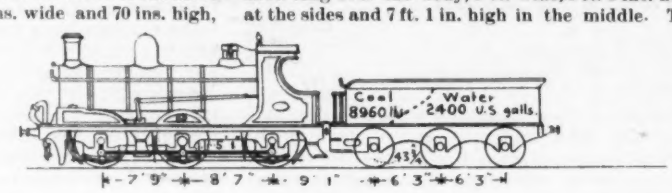
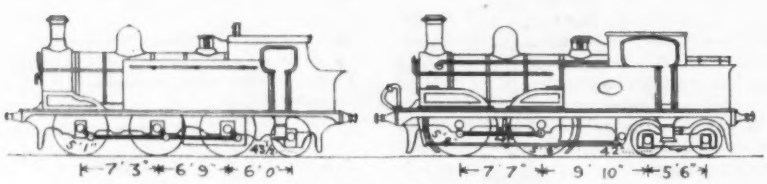



Fig. 25. Freight Engine.




Figs. 26 and 27. Tank Engines.

LOCOMOTIVES; LANCASHIRE & YORKSHIRE RAILWAY, ENGLAND.

DIMENSIONS OF LOCOMOTIVES.

| | Passenger. Fig. 24. Ins. | Freight. Fig. 25. Ins. | Double-end tank. Ins. |
|---|---|---|---|
| Cylinders | 18 × 26 | 18 × 26 | 18 × 26 |
| Diam. driving wheels | 72 | 61 | 68 |
| Diam. truck or carrying wheels | 36½ | ..... | 43¾ |
| Diameter boiler | 50 | 50 | 50 |
| Number of tubes | 220 | 220 | 220 |
| Diam. of tubes | 1¾ | 1¾ | 1¾ |
| Length of tubes | 11 ft. 1½ in. | 10 ft. 9⅝ in. | 10 ft. 7⅝ in. |
| Heating surface: | | | |
| Tubes, sq. ft. | 1,121.32 | 1,102.26 | 1,108.73 |
| Firebox, sq. ft. | 107.68 | 107.68 | 107.68 |
| Total, sq. ft. | 1,229.00 | 1,209.94 | 1,216.41 |
| Driving wheel base | 8 ft. 11 ins. | 16 ft. 4 ins. | 8 ft. 7 ins. |
| Total wheel base | 21 ft. 10⅛ in. | " | 24 ft. 4 in. |
| Weight: | Lbs. | Lbs. | Lbs. |
| On leading axle or truck | 30 912 | 30,968 | 30,240 |
| On driving axle | 33,600 | 33,600 | 39,.00 |
| On coupled axle | 32,480 | 29,848 | 31,920 |
| On trailing axle | ..... | ..... | 25,760 |
| Total | 96,992 | 94,416 | 127,120 |
| Tank, U. S. gallons | 2,400 | ..... | 1,607 |
| Coal space, lbs. | 6,720 | ..... | 4,480 |

All these engines have inside cylinders. Tenders and tank engines are fitted with scoops for taking water from track tanks. The scoops are operated by the vacuum of the brake pipe. On tank engines the scoops work both ways, so that the engines can take water when running bunker first. Oil fuel is in use on a tank engine, and a main line passenger engine is being fitted with the apparatus for burning this fuel. A coal fire is built on the grate, and the oil sprayed over it by two injectors. The system is said to work satisfactorily. The Joy valve gear is used on a number of engines, and is looked upon with favor. Screw-reversing gear is now generally used. On large engines the slide valves are placed on top of the cylinders. Cast steel wheels are being extensively applied. The automatic vacuum train brake and vacuum driver brake are used. The engines are painted black, with red striping and a little brass work. Mr. J. A. F. ASPINALL is the Chief Mechanical Engineer of the line.

*Rolling Stock.*—The passenger equipment includes a considerable number of cars on four-wheel and six-wheel trucks. Some of the latter have 7 compartments of first and third class, the first class forming a saloon. A composite car—*i. e.*, one with compartments for different classes—on six-wheel trucks is shown in Fig. 28. It has 4 third-class compartments (40 passengers), 1 second-class compartment (10 passengers), 1 first-class compartment (5 passengers), a lavatory in communication with the first-class compartment, and a baggage compartment. The lavatory is 30 ins. wide and extends across the car. Between it and the first-class compartment is a passage 36 ins. wide, also extending across the car, and having doors opening into the lavatory and compartment. The lavatory is thus only available for 5 out of the 55 passengers, and the passage is so much waste space. These cars are 51 ft. long over the body, 8 ft. wide, 6 ft. 3 ins. high at the sides and 7 ft. 1 in. high in the middle. The trucks have 6 wheels 42 ins. diameter, with a wheel base of 11 ft. 6 ins. The distance c. to c. of trucks is 29 ft. 6 ins. Some of the older cars on 2 or 3 rigid axles have seats covered with gray horse hair cushions, and a strip of similar cushion or padding on the partitions at about the height of the passengers' shoulders. Some of these cars have only one window between the doors of adjacent compartments, each compartment getting half the window, and a strip of glass being used to fill out the partition to contact with the window pane. The newer cars are fitted with a valve attachment by means of which the passenger can, on emergency, apply the brakes. To do this they have to break a piece of glass covering the handle. Oil lamps are used in the older cars, but the later cars are fitted with the Pope Patent Lighting Co.'s system of compressed gas manufactured from oil. Iron freight and caboose cars are used to some extent, and some of the latter are marked "Fire Extinguisher," being fitted with hand pumps. The passenger cars are painted a dark chocolate brown up to the level of the window sills, and cinnamon brown above. The lettering is in gilt. English cars do not have the name of the railway painted upon them, but have the initials of the road and the number of the car; while on each door, as a rule, is painted the name or number of the class of the compartment.

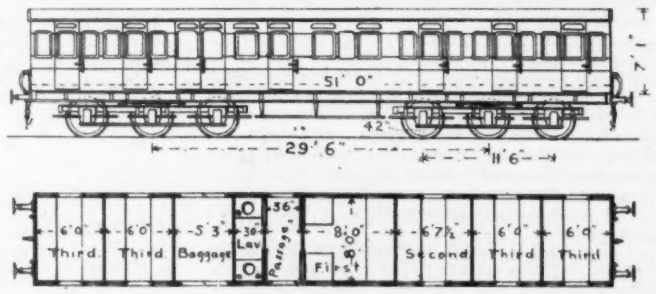



FIG. 28. PASSENGER CAR ON SIX-WHEEL TRUCKS; LANCASHIRE & YORKSHIRE RAILWAY, ENGLAND.

*Car Heating.*—The heating of passenger cars has been from the first a universal practice on the railways of the United States, and at present the use of steam from the locomotive is rapidly becoming the universal mode of heating. On English railways, however, the cars are only heated by means of foot warmers. These are flat cases of galvanized iron or other material, about 24 ins. long, 10 ins. wide and 4 ins. deep. They are generally filled with water or a brine solution, and are kept in boiling water until required. They are placed on the floor between the seats, but the arranging of foot warmers for 10 pairs of feet in a full compartment is attended with some inconvenience. The method is extremely crude, and would be unsatisfactory even if properly and systematically carried out, but in practice the supply is generally insufficient, and the water is often far from being hot. The Lancashire & Yorkshire Ry. Co. has ordered a large number of these foot warmers to be made for

the use of third-class passengers, many complaints having been made as to the discomforts and dangers of traveling in cold cars. The inefficiency of these heaters and some of the inconveniences of the English compartment cars were shown very clearly during the blizzard in England this month, when several trains were snowbound. The passengers had either to sit in isolated groups in the compartments, or, as in some cases, where fuel was available, gather round fires in the open air, to warm themselves and their water bottles. In similar cases on American roads, the passengers generally assemble in one or two of the cars, having heat from steam pipes or stoves, and thus have the benefits of company, of sharing such supplies as they may have, and of taking concerted action for amusement, foraging or relief. Mr. ACWORTH, in his "Railways of Scotland," mentions steam heating as having been tried on the Caledonian Ry. and a hot water circulating system on the Glasgow & Southwestern Ry. Very little attention is given to the matter in England, owing partly to the winters being usually comparatively short, and in spite of the many discomforts of traveling in cold weather there is apparently no prospect of the adoption of any system of car heating.

*Horwich Works.*—The company has established extensive works at Horwich, near Manchester, for the construction and repair of locomotives, and the carrying out of the mechanical engineering work of the line. They were commenced in 1886 and completed in 1889. They turn out about 50 new engines a year, besides extensive repair work. The present capacity is one complete engine per week, but the works are being enlarged to enable them to turn out two per week. A general plan is shown in Fig. 29. About 85 acres of land are inclosed, and the shops cover an area of 13½ acres. The shops are well arranged and well built, and have plenty of light and air. The offices are in a building (*A*) 323 × 58 ft. The general offices are very nicely fitted up, and have electrical connection with the drawing office, shops, etc. The drawing office is a large, pleasant room, with ample light. For reproducing copies of the drawings a photographic process giving dark purple lines on a nearly white ground is used in preference to the blue print process, as the prints are clearer and can be colored. Mr. TETLOW is the chief draftsman. In this building are a laboratory, fitted up with the requirements for the analysis of materials and a test-room with a 100-ton testing machine. The general stores building (*B*) is 198 × 111 ft., with a gallery round the four sides. It is fitted with weighing machines and hydraulic cranes for receiving and storing heavy materials. The boiler-shop (*C*), 364 × 111 ft., is fitted with a pair of hydraulic pumps and accumulator; two large fixed hydraulic riveters, each having an overhead hydraulic crane for lifting boilers when riveting; three portable overhead riveters or swing cranes, bolted to walls and columns, and three overhead traveling cranes. In addition there are the ordinary machine tools for a boiler-shop, with special machines for drilling, etc. The smithy (*D*), 210 × 111 ft., is provided with 12 double and 31 single hearths, reheating furnace, bolt and nut making plant, circular saws, steam-hammers, etc. The forge (*E*) is 362 × 111 ft., and contains Siemens regenerative furnaces for reheating, a 14-in. merchant mill and 8½-in. guide mill, together with the necessary plant for the general work of a forge and rolling mill. The steel foundry (*F*) is 150 × 111 ft. It contains 2 Siemens-Martin regenerative melting furnaces, having a high-level tramway for carrying the ladle, and a narrow gage tramway below for the mold trolleys or cars. The latter track runs through to the forge and rolling mills. The furnaces in the steel foundry and forge are heated by gas from a series of Wilson gas producers. The iron foundry (*G*), 212 × 111 ft., is fitted with 2 cupolas, supplied with blast from a Root blower. Hydraulic power is used for working the cranes, and there are 2 overhead rope power traveling cranes. The formation of the ground necessitates the rail level at the rear of the foundries being considerably higher than the floors, which permits of coke and iron being unloaded and wheeled direct to the charge holes of the cupolas.

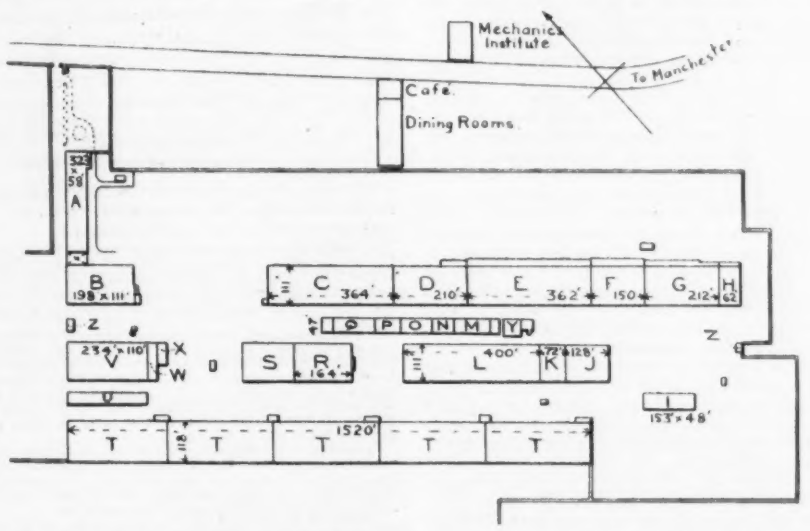



FIG. 29. PLAN OF LANCASHIRE & YORKSHIRE RAILWAY CO.'S LOCOMOTIVE WORKS AT HORWICH, ENGLAND.

A, Offices; B, General Stores; C, Boiler Shop; D, Smithy; E, Forge; F, Steel Foundry; G, Iron Foundry; H, Chair Foundry; I, Signal and Spring Smithy; J, Signal Shop; K, Frog and Switch Shop; L, Fitting Shop; M, Brass Foundry; N, Tinsmith's Shop; O, Coppersmith's Shop; P, Tire Shop; Q, Telegraph Shop; R, Joiners' and Patternmakers' Shop; S, Millwrights' Shop; T, Erecting Shops; U, Engine Shed; V, Paint Shop; W, Chain Testing Shop; X, Chain Smithy; Y, Boiler House; Z, Check Lodges.

The gas producers for the furnaces are also charged direct at the top, while the ashes are drawn out at the bottom into the narrow-gage cars. The chair foundry (*H*), 62 × 128 ft., has 2 cupolas charged from the high level. A staging is provided for fettling the chairs, which are then conveyed to the railway cars on an endless chain. The signal and spring smithy (*I*), 153 × 48 ft., has 2 gas-heated spring furnaces, hydraulic spring-buckle stripping and fixing machines, and a steam hammer for stamping. The signal-shop (*J*), 128 × 111 ft., and the frog and switch-shop (*K*), 72 × 111 ft., are fitted with special tools for their respective work. The former has also a rack saw for signal posts. The fitting shop (*L*) is 400 × 111 ft. It is fitted with a number of special machine tools for locomotive work, including crank axle lathes, milling, planing and slotting machines, and a large milling machine for cutting out crank axle webs. They are driven by 2 wall engines placed at the end of the shop, which give motion by means of bevel gearing to 4 ranges of shafting, running longitudinally, and to 3 high-speed rope jib traveling cranes of 5 tons capacity, which control the principal heavy machines. The brass foundry (*M*) is 105 × 47 ft., and contains a gas furnace and gas crucible furnace for melting. The tinsmiths' and coppersmiths' shops (*N*, *O*) are 150 × 47 ft. The telegraph shop (*Q*), 155 × 47 ft., has a testing room and special tools for the repair and renewal of electrical fittings and block signal instruments. The joiners' and pattern makers' shop (*R*) has modern wood-working machinery, and has a gallery on the four sides for the storage of patterns. It is fitted with a sprinkler arrangement for protection against fire. The 5 erecting shops (*T*) occupy a building 1,520 × 118 ft. They are provided with 20 overhead power cranes of 30 tons capacity, driven by wall engines. Access for engines to the center portions of this long shop are obtained by 2 traversers. Wheel lathes are placed at various positions for conveniently dealing with wheels taken from engines under repair. The paint shop (*V*) is 234 × 110 ft., and has a "weaving shed" type of roof, thereby obtaining a light free from the glare of the sun. Paint grinding and mixing machines are provided, and arrangements made for the thorough heating of the shop during winter. The chain testing shop (*W*) is 110 × 27 ft., and the chain smithy (*X*) 64 × 28 ft. The former has a hydraulic testing machine. The plant of the works includes a number of milling mahines, multiple drills, and other machine tools of the most modern design. For heavy forgings there is a horizontal duplex steam hammer, consisting of two cylinders with pistons and rods; the forging is placed between the hammer heads on the ends of the plungers. The weight of each tup is 35 tons, and the steam pressure 100 lbs. per sq. in. There are 5 miles of track of 18 ins. gage for the carriage of materials, locomotives being used for the heavy work. The gas works are on the southwest boundary, and at a much lower level than the rest of the works. Dining rooms have been built for the use of the men coming from a distance. They have accommodations for 1,000 men, whose meals are cooked or heated by the attendants. A café has been built, which is provided with rooms for chess, checkers, billiards, etc. The company has also erected a mechanics' institute, containing a lecture hall, library, reading-room, class rooms, lavatories, etc.

E. E. R. T.

[*To be continued.*]

## Artesian Well Practice in the Western United States.

### III.

(*Continued from p.* 248).

In our issue of March 14 some features of the artesian wells of the two Dakotas were considered. In the area covered by the government investigations under review, perhaps the next artesian basin in interest after the Dakota basins is the Denver. All of the other basins were mentioned in our issue of Feb. 21, and the names of the gentlemen who conducted the investigations for the various districts were given in the review of the report which will be found on p. 155 of the present volume.

KANSAS AND NEBRASKA.

Before passing to the Denver basin some facts may be given regarding the great central district, under the charge of Field-Agent J. W. GREGORY, of Garden City, and including all of Kansas, Nebraska, Indian and Oklahoma territories west of the 97th meridian, and that part of Colorado east of the 103d meridian. The geology of Nebraska, as set forth by Prof. L. E. HICKS, of Lincoln, is very interesting, owing to the recent date of the formation. The formation is thought to be very favorable for artesian wells, although but comparatively few have been sunk. The deepest well in Nebraska, noted in the report, is at Omaha, 634 ft., and was sunk by the Union Pacific Ry. Co. With the exception of a large group of some 150 2-in. wells in Meade Co., Kan., the wells of Kansas and Nebraska, so far as stated, are generally 6 ins. in diameter, but it is probable that the other wells are smaller. No satisfactory figures of cost can be given for these states, save that $1 per foot seems a common price. Kansas wells range in depth from 20 to 1,076 ft., one of the latter depth being in Harvey Co. The flow and pressure in each state seems to be slight.

THE DENVER BASIN.

The Denver basin, in Colorado, is notable because of the large number of wells put down within a small area, and the fact that wells formerly flowing are now of use only by the aid of pumping. In other words, the basin has been overtaxed, not so much, if at all, as to quantity of water as to quantity of flowing water.

The Denver basin is an elongated oval, with the Platte River as an axis. It is about 25 miles wide

and 70 miles long, with an elevation of from 4,900 ft., at Fort Lupton, at the north, to nearly 6,000 ft., at Sedalia, at the south end of the basin. Field Agent L. G. CARPENTER, of Fort Collins, Col., states that the locations of 215 wells have been ascertained. The number in Denver in 1884 was estimated at 80, and since then must have increased to at least 100, which would make 335 within the basin. It is stated that about 250 of these wells are still flowing.

The strata pierced by the wells of this basin have uniform characteristics, but are variable both in the layers struck and the thickness of layers of the same material. The strata passed through at the Anderson well, Denver, were as follows:

| | Thickness of strata, ft. | Depth below surface, ft. |
|---|---|---|
| A seam of gravel and surface wash | .. | 12 |
| Clay | 17 | 29 |
| Sandstone | 1 | 30 |
| Hard clay | 94 | 124 |
| Hard sandstone | 8 | 132 |
| Clay-slate | 22 | 154 |
| Sandstone (first flow) | 14 | 168 |
| Hard clay | 24 | 192 |
| Sandstone | 2 | 194 |
| Very tough hard clay | 50 | 244 |
| Sandstone (second flow) | 16 | 260 |
| Hard clay | 30 | 290 |
| Sandstone (third flow) | 10 | 300 |
| Blue clay | 8 | 308 |
| Sandstone (fourth flow) | 12 | 320 |
| Soft clay | 15 | 335 |
| Dark hard clay | 15 | 350 |
| Loose white sandstone (fifth and greatest flow of water) | 25 | 375 |
| Total depth of old well | 375 | 375 |

The artesian well at the Kansas Pacific shops, East Denver, pierced strata as follows:

| | Thickness of strata, ft. | Depth below surface, ft. |
|---|---|---|
| Sand and gravel | 18 | 18 |
| Clay | 5 | 23 |
| Soft sand rock | 50 | 73 |
| Clay | 3 | 76 |
| Hard sand rock, streaks of clay | 60 | 136 |
| Clay | 10 | 146 |
| Hard sand rock streaks of clay | 134 | 280 |
| Artesian strata | 7 | 287 |
| Hard sand rock, streaks of clay | 248 | 535 |
| Artesian strata | 17 | 552 |
| Shale | 5 | 557 |
| Hard sand rock, streaks of clay | 41 | 598 |
| Artesian strata | 35.4 | 633.4 |
| Hard sand rock | 1 | 634.4 |

The variability of conditions is further illustrated by the fact that the Bemis well, at Littleton, struck three good flows of water within 375 ft., while a well on Littleton Heights, not 500 ft. distant, struck but one flow within 800 ft., and that was at a depth of 458 ft. The strata do not undulate with the surface of ground. At Denver there is a 375 and a 600 ft. flow. At Littleton there are flows from four strata, defined according to temperature, which varies from 46½° to 65°.

The decrease in flow in the Denver basin is thus discussed by Prof. CARPENTER:

In the early days of the Denver basin nearly all wells were flowing wells, but with the continued tapping of the strata it became more common to secure only pumping wells, even in regions where flowing wells had been previously secured.

About an average flow was from 5 to 100 galls. per minute in the immediate vicinity of Denver. In the first few years of the development of the basin the wells were of small bore, as water was wanted for domestic use only. The supply was often insufficient for hotel or manufacturing purposes, and it became common to introduce pumps, which by lessening the pressure in neighboring wells caused pumps to become necessary. In consequence the bore of wells has been gradually increased, until now it is frequently 6½ ins.; a few are 8 and one or two are 10 ins.

In the basin outside of Denver differences in flow are noticed according to the locality. Near Brighton, and for several miles toward Denver, the flow does not often exceed 1 or 2 galls. per minute. Some 6 or 8 miles above Brighton there are some good flows of 30 to 40 galls. per minute, but the best wells seem to have been obtained above Denver or in its vicinity.

Some of the wells are reported as remaining unchanged in flow, a few have increased, but as a general thing the report is that the flow has fallen off, sometimes entirely ceased. Many of the later wells, especially in Denver, do not strike flowing water at all. Frequently the diminution is due to the tapping of the water strata by other wells in the vicinity, thus opening other outlets, or outlets at a lower level.

The decrease in flow may be due to several causes: From other wells piercing the same stratum and lessening the pressure; from filling up with sand, stopping the flow; from insufficient casing, allowing the water to flow into upper strata instead of conducting it to the surface.

The decrease in flow from piercing the same stratum is best shown by the Charles well, of Denver, because that was the first to go through the 600-ft. flow. The pressure was quite constant, ranging from 68 to 71 lbs. per sq. in. When the Daniels & Fisher well was sunk, a few blocks away, the pressure decreased to 10 or 15 lbs., and after the McClelland well was sunk the flow was entirely lost for about a day, then reappeared with a pressure of about 10 lbs. When the two latter wells were connected the pressure in the Charles well again increased. Since that time a large number of wells have pierced this stratum in Denver, and so many have resorted to pumping that the flow has entirely ceased.

Mrs. ECKHART'S well, in North Denver, which had been flowing with a pressure of 35 lbs., ceased entirely when the Gurley well struck the same stratum at a lower level.

The Windsor and the Barclay wells are each at the corner of Eighteenth and Laniver streets, separated by the street and a portion of their respective blocks. The Windsor well was completed August 30, 1883; the Barclay, August 4, 1884.

At different measurements this well had the following discharges:

| | | |
|---|---|---|
| March, 1884 | Flow in gallons per minute | 67½ |
| May 6, 1884 | " " " | 40 |
| June 6, 1884 | " " " | 32 |
| August 4, Barclay well completed. | | |
| August 5 | Flow in gallons per minute | 15 |

A portion of the failure from June 6 to Aug. 5 should be attributed to the seasonal variation. The decrease in flow and the entire cessation of most of the wells in the immediate vicinity of Denver can be mostly attributed to this cause. So well is this recognized that flowing wells are not now expected in this immediate vicinity.

But outside the city of Denver there is little reason to think this cause has been influential in more than a small degree. The wells, however, have diminished in most cases, but the cause seems to be from the well having filled to some extent with sand or defective casing, which allows the waste of the water in the upper porous layers. In many cases cleaning has been resorted to, and the flow, or a great part of it, has been recovered.

The following are examples where this has been done:

Mrs. COOK'S well, on Cherry Hill farm, flowed 20 galls. per minute when sunk. It failed so that there was almost no flow. After cleaning, it regained one-half its flow.

The well of R. W. CURTIS had a flow of 4½ galls. per minute in March, 1888. In January, 1890, it had decreased to 1½ galls. The well was found to be filled up to the flow at 350 ft. After cleaning out, the flow increased.

The Harrington well had a flow of from 8 to 14 galls. per minute for three months after completion, when it failed. It was then cleaned, and the flow was increased to from 4 to 8 galls. This lasted for several weeks, when it failed. This well seems to have been subject to caving.

The Barclay well, which was sunk in 1884, had a flow of 40 galls. per minute, which had decreased in May, 1886, to 10 galls. Before cleaning (May 14), measurement showed the flow to be 10½ galls. per minute. During the operation the flow was measured several times. The progressive increase is noticeable.

May 15 the flow had become at 4 A. M., 17, at 6 A. M. 21¾, and at 9 A. M. 32 galls. per minute.

Early in July following the well was found to have again filled up 42 ft. and the flow to have decreased to 8 galls. per minute.

In the above cases it is noticeable that the full flow is not recovered. A part is due to seasonal variation; a part may be due to the reduction of pressure consequent on the increase in the number of wells.

In the country the cause most influential in bringing loss is probably poor or insufficient casing. Actuated by motives of economy the common practice is to case only through the loose material down to the stratified formations, unless the formation below caves so badly that casing is necessary. The pressure of the lower water strata is almost always greater than the upper. The consequence is that the water from below has the opportunity to enter the strata at less pressure above, or the dry sandstone, and the flow from the well is lost or lessened.

Similarly the packing at the junction of the stand-pipe and the first bed of clay is often defective. In such a case the water is allowed to fill the upper layers of the soil. The loss in water and in pressure may be great. The consequences are not confined, unfortunately, to the one well, but to the whole adjacent basin, and the damage may be irreparable. The fact that such careless work may be done, and the damage so great, suggests that in basins of such character it is a matter of public importance that each person putting down a well should be required by law, if necessary, to thoroughly case and pack his well.

The variation in the flow of wells according to the character of the seasons has become a commonly accepted fact. The upper strata show the effect sooner than the lower, and the wells near the mountain quicker feel the effect of a dry season than those of Denver.

Mr. WADSWORTH, of Arvada, a good observer, says:

Our artesian wells come and go with the seasons. When the little streams in the foothills are pouring their contents into the loose rocks so as to dry up before reaching the valley, artesian wells in Denver and vicinity work all right; but when the streams fail in the foothills some of the wells cease to flow.

The most careful series of measurements of an individual well that has been obtained is that of Mr. DWELLE on the Barclay well from 1884 to 1887 and the Windsor well in 1883 and 1884.

The Barclay well was completed Aug. 4, 1884, to a depth of 602 ft. Two flows of water were struck and each was kept separate by casing. The measurements of Mr. DWELLE, reduced for convenience to gallons per minute, are as follows:

| DATE. | Upper flow per minute. Galls. | Lower flow per minute. Galls. | DATE. | Upper flow per minute. Galls. | Lower flow per minute. Galls. |
|---|---|---|---|---|---|
| Aug. 4, 1884. | 4½ | 36 | April 8, 1886 | 0 | 12 |
| Jan. 24, 1885. | 7½ | 51 | May 14, 1886‡ | 0 | 10½ |
| Mar. 9, 1885. | (*) | (*) | May 15, 1886 (4 A. M.) | .. | 17 |
| Nov. 8, 1885. | 5 | 35½ | May 15, 1886 (6 A. M.) | .. | 21¾ |
| Jan 27, 1886. | 0 | 12 | May 15, 1886 (9 A. M.) | .. | 32 |
| Feb. 6, 1886† | 3 | 14 | July 9, 1886§ | 0 | 8 |
| Feb. 15, 1886. | 9 | 37 | Jan 17, 1887 | 0 | 7½ |
| Feb. 19, 1886. | 5½ | 27 | | | |

* Both flows, 40 galls. ‡ Cleaning begun.
† It was found the well had filled 19 ft. to this date.
§ Well had again filled 42 ft.

The Windsor well, 530 ft. deep, was also under the charge of Mr. DWELLE, and was measured by him as follows:

| DATE. | Upper flow per minute, galls. | Lower flow per minute, galls. | Both flows, galls. |
|---|---|---|---|
| Aug. 30, 1883 | .... | .... | 208 |
| Nov. 10, 1883 | ... | 127 | .... |
| Nov. 14, 1883 | .... | 124 | .... |
| March, 1884 | .... | 67.5 | .... |
| May 6, 1884 | 8.7 | 29.3 | .... |
| June 6, 1884 | .... | .... | 32 |
| Aug. 5, after the Barclay well had been struck | 1.8 | 13.3 | . |

February 15, 1886, to April 6, the well was deepened. It is now pumped.

The fluctuation in the flow is noticeable, and especially the increase in Feb. 1886, in the Barclay well.

Mr. DWELLE, in reply to a letter, says:

I ascribe the fluctuations to two causes, viz., the cleansing of the wells by removing the sand and pulverized clay which had gotten into them, presumably with the water, and to the difference in the quantity of water which was being delivered to the uplifted strata which convey the artesian supply.

It will be noticed in the cases of the sudden changes of amount of flow that the least quantity flowing was in the late fall or early winter, as a rule, when there was the least amount of snow melting and the least quantity of water in the streams; while the greater flow in connection with these sudden changes was in the early spring following, when the snow was rapidly melting and the streams were full of water.

In case of the sudden change noted in February, 1886, I made a mental note at the time, as I remember that the latter part of January of that year and the month of February were very open, and there was a great deal of rain in addition to the melting snow at that time.

After the cleaning of 1886, the continued small supply is undoubtedly to be attributed mostly to the drain upon the supply caused by the number of new wells in the immediate vicinity.

The increase in flow reported in several cases is due to two causes, to the opening of the small channels through the water-bearing rock by the passage of the water, and to the formation of chambers of greater or less size at these places. The rapidity with which the water can pass through the sand rock under a given pressure is limited. But if the area of the surface through which the water issues is increased, the quantity of water available is correspondingly increased. The application of this is often seen in dug wells, for it is well known that the larger the well the more water it can furnish.

Nearly all the wells seem to form a cavity or small reservoir at these strata, as evidenced by the sand brought up. In the Denver Basin this is usually in small quantity, the largest amount of sand reported being two wagon loads, or say 50 cu. ft. Ten or 15 cu. ft. are more common.

The large wells flow more than the small ones, but this is principally due to the less friction and consequently the less loss of pressure the water suffers before reaching the surface.

While the water supply of the Denver Basin is as permanent as the season, it is limited, as the diminution of the flows show, and the number of wells cannot be indefinitely extended. In Denver, indeed, it is probably already exceeded, though if pumping should cease most of the wells would recover their flow.

The diminution does not show that the limit of the basin has been reached, but simply that the water is taken from that vicinity faster than it can be supplied by percolation through the rocks. Outside of Denver there is opportunity for more wells and many are being put down.

The deepest well within the City of Denver is at the court-house, 930 ft. This well, says Prof. H. P. VAN DIEST, C. E., has reached the Laramie formation, very likely at one of the top sandstone layers. Prof. VAN DIEST adds that the basal sandstone of the Laramie probably lies about 1,500 ft. beneath the city, or, in other words, that the Montana shales would not

be reached until this depth, and that probably a large supply of water could be secured from these thick sandstone layers, as they crop out at a higher level and are fed by streams nearer the mountains than are the beds from which the present wells take their supply.

The geology of the Denver basin is further described by Prof. VAN DIEST as follows:

The Platte valley from Sedalia to Platteville is, in Eastern Colorado, in the most favorable condition to secure artesian water under pressure. There, between the foothills and the anticlinal axis directly west of the Box Elder Creek, is formed a basin, which on the south is limited by elevated country. It is not an ideal basin, closed in on all sides by upturned strata, but of a horseshoe shape, its curve extending from the base of the Laramie formation along the south banks of the St. Vrain and Boulder Creeks toward Golden, southerly to a mile and a half east of Morrison; thence south and southeasterly to Sedalia; thence northeasterly, crossing Coal Creek toward the Box Elder. This line connects points 5,650 ft. above sea level, and is from 300 to 400 ft. above Denver. The greatest width of the Denver basin is nearly 30 miles, and its length about 55 miles.

It will be seen that the extent of the basin, as given just above, differs from that stated at the beginning of the article, which was 25 miles wide by 70 long. But Prof. VAN DIEST says that it may extend farther to the south, and difference in width is not significant when we consider the indefiniteness of the data upon which such conclusions are based.

The deepest well in the whole Denver basin is at Sedalia, 1,440 ft., but water was struck at a depth of 218 ft., and none below. It is one of the most southerly wells in the district, was sunk in 1887, has a flow of 12 galls. per minute and a pressure of 10 lbs. Its yield has remained unchanged, but pumping is necessary, as the water rises only to a point 50 ft. below the surface. It is cased with 5 and 3-in. pipe, and is used for a railway supply. The shallowest well has a depth of 135 ft., a diameter of 2½ ins., a flow of 3 galls. per minute and a pressure of 3 lbs. It is at Island Station, Arapahoe Co. A bowlder was struck at 135 ft., which prevented further boring.

The records of some of the wells in the Denver basin are very complete, a record of many of the Denver City wells having been kept in the City Engineer's office.

Further details regarding the wells of this basin will be given in a later issue, in connection with some facts concerning Texas wells.

*(To be continued.)*

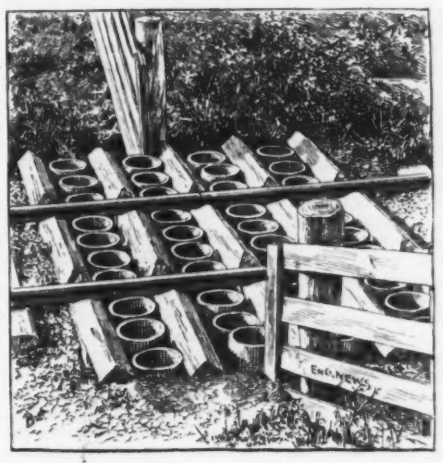
## The New York State Roads Improvement Association.

At the first annual meeting of this association at Syracuse, Feb. 26, Mr. W. A. SWEET presided. Secretary I. B. POTTER, in his annual report, said that road improvement associations had been formed in many other states besides New York, and he especially mentioned Pennsylvania, Massachusetts, Rhode Island, Illinois, Tennessee and Georgia. The New York associations, last November, addressed a letter to Secretary of State BLAINE asking that he instruct United States consuls to forward statements regarding the practical results brought about by the use of improved roads and their value to farmers as compared with ordinary dirt roads. Various consuls have forwarded information on this head, and this matter will be shortly published. As the result of careful investigation and much correspondence, Secretary POTTER said that he found that of the general state tax to be levied for road construction under the RICHARDSON bill, 92% would be paid directly by the incorporated villages and cities; leaving only 8% to be paid by the farming community, whom this improvement would greatly benefit.

Senator W. P. RICHARDSON, of Orange Co., in speaking of roads, and especially of the features of his road bill, said that farmers complained that they were already too much taxed, and were opposed to an increase for the purpose named. He said the trouble was that they did not distinguish between state and local tax; the burden was in the latter. Assuming that an average 100-acre Onondaga Co. farm was worth $5,000, and taking the state tax at 27 cts. on $100, the state tax on this farm would be $13.50. The total state tax last year was $9,000,000, and the sum proposed to be raised annually for roads, under the Richardson bill, would not exceed $700,000. This is about one-twelfth of the total tax, or it would add $1.25 to the $13.50 tax on the 100-acre farm. This is very small as compared with the benefits to be derived by the farmer.

## The "Common Sense" Cattle Guard.

The novelty in cattle guards shown in the accompanying cut consists simply of four rows of 10-in. tiles, 18 ins. long, set on end between ordinary ties, the latter being capped on top by triangular pieces of wood spiked on. The tiles are so set as to come within about 1 in. of the top of the rail, being tamped about with ballast. A few of these guards,




A Sewer Pipe Cattleguard.

we are informed, have been in use in Iowa for the past two years with very excellent results. There has been no expense for maintenance whatever, as it forms a perfect cattle guard, it being impossible to drive cattle on it.

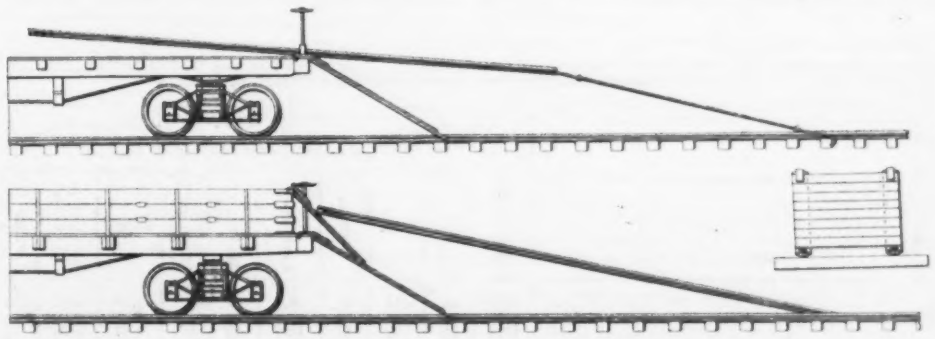
Should the holes fill with snow, as of course they will in a snowstorm, a light scoop is used by which the pipes are readily cleaned out. Care is taken to have sufficient drainage, so that water may not stand in the pipe and freeze, by putting a bed of about 2 ins. of coarse gravel under the tiles, thus avoiding what might otherwise be a danger of some moment. The cost of the tiles in Iowa is about 15 cts. each f. o. b. at the factories, making the cost of the guard as shown $6, in addition to transportation and cost of putting in place. Wing extensions may be added at slight additional expense.

Some of these guards have been in use for some time on the Chicago, Burlington & Quincy R. R. and the Keokuk & Western R. R. and the Rock Island and other Western roads are now putting in some. The guards are not sold on royalty, but the right to use is sold for entire roads at a price based on mileage. Permission will be granted to any road on application, we are informed, to put in one or two guards on trial free of charge for royalty.

The guard, as shown, was patented Oct. 8, 1889, by Messrs. Kellogg, Baker & Stearns, of Garden Grove, Ia. It strikes us as rather a happy idea, which is likely to be effective, and should certainly be cheap and durable. Not the least advantage is that breakage, if it occurs, does not disarrange the whole guard, nor involve trouble in renewal. So far as mere effectiveness goes, there can be nothing better than the old-fashioned open pit; but the difficulty of making the track ride smoothly over such pits, and of keeping them in good order, not to speak of their first cost, is causing a strong tendency toward some form of surface guard; and among guards of that type it is difficult to see why the one illustrated should not establish its right to a high rank. We give the name of this device as sent to us by the owners, but would caution them, and our readers, that there is on the market another cattle guard with this name, manufactured by the Bush Surface Cattle Guard Co., of Kalamazoo, Mich. which was illustrated in ENGINEERING NEWS, Feb. 21.

## An Improvement in Methods of Unloading Rails.

There is no one thing about which the average track foreman complains more bitterly, or which is more often offered as an excuse for rough riding track, than surface-bent rails, the causes for which are manifold; but of all the causes, the manner in which the rails are unloaded is, perhaps, the most fruitful. The practice in this respect differs with almost every supervisor. Some prefer to unload the rail in a pile, by using two rails as skids to slide the rail from the car to the pile, then trucking the rail to the point desired. Others distribute from the moving car by hand, dropping the rail on the ballast or berm as the train moves slowly along. Some unload from the rear of the car, by pushing the rail out over the end, men on the ground supporting the weight and laying it on the ties, more or less gently; the train then moves up a car length, and the operation is repeated; while others unload by having two ropes about 20 ft. long, each with an L-hook in one end and a claw hook in the other, the operation being as follows: Two men operate each rope, occupying a position at each side of the end of the car. The L-hook is inserted in the bolt hole in the rail and the claw hook is hooked over the end of a tie. The train is then started and the rail is dragged out over the end of the car. As the opposite end of the rail approaches the end of the car it is either allowed to fall on the ties, or is taken hold of and lowered to the ground by four men with rail tongs; a rail length is then skipped before another rail is hooked, and the operation goes on alternately by the two gangs, the train keeping in motion. The territory is gone over again afterwards to fill in the vacancies in the distribution.



AN IMPROVEMENT IN METHODS FOR UNLOADING RAILS.

This latter plan is a great improvement over the others in many ways, but it has the objection that if the rail is dropped it is liable to become bent, and if handled by the men there is danger of injury to them by their own or others' carelessness in working around the rails.

A modification of the last-named plan to avoid these difficulties, which is clearly shown by the sketches herewith, has been used for some time on one of our western roads, as follows:

A tail gate is attached to the car by two iron claws bent to the proper angle and furnished with cutting edges, and the end of the gate is allowed to drag along on the rails. The operation of dragging off

the rails is then carried on simultaneously on both sides. As soon as the first end of the rail touches the ground the ropes are detached and another rail hooked, so that the distribution is complete and continuous. The gain is evident, there being no necessity for the men to put themselves in any dangerous place, and no danger of bending the rails. With solid end gondolas a double tail gate is used, and the rails are lifted up by men on the inside of the car. The following record was made by one supervisor in his first use of the method:

| | Rails. | Minutes. |
|---|---|---|
| Drop end gondola. | 71 | 35 |
| " | 71 | 26 |
| " | 71 | 17 |
| Solid end gondola. | 58 | 34 |
| " | 58 | 33 |
| " | 86 | 42 |
| " | 58 | 29 |
| " | 58 | 33 |
| " | 86 | 49 |

At other times 4 solid end gondolas and 2 drop end gondolas have been unloaded in 3½ hours; 15 flats in 6 hours, and 21 flats, containing 1,120 rails, in 11 hours. It is evident that, with a drop of 4 or 5 inches, no damage can be done, and that the method has peculiar advantages, both in speed and safety, economy and freedom from surface bending.

We regret that we are unable to give the proper credit for this device, because of the fact that neither the drawing nor the accompanying description bore the name of the author, and an accompanying letter, which related also to other matters, was passed along to our business office and by it feloniously destroyed. We hope to be able to correct this omission in a following issue, having no other method than publication for doing so.

## CONSTRUCTION NEWS.

### RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

***Baltimore & Ohio.***—Tracklaying on the Akron & Chicago junction R. R., which was discontinued during the winter, has been resumed, and will be pushed as rapidly as possible.—Grading has been suspended on the line from Uniontown, Pa., to Morgantown, W. Va.

***Pittsburg, Shenango & Lake Erie.***—The grading is now nearly completed on the extension of this road from Dixonburg to Girard, Pa., 26 miles, and work on masonry and bridges is well advanced.

***Philadelphia & Reading.***—Property is being demolished along the route of the new elevated terminal line at Philadelphia, Pa., preparatory to commencing construction.

***Pennsylvania.***—The line of the McKeesport & Bessemer R. R., connecting the Monongahela River Division, with the factories at McKeesport, Pa., 5 miles long, is now completed with the exception of the bridge across the Monohgahela River.

***Herkimer, Newport & Palemal.***—Surveys are now in progress for the proposed extension of this railway into the Adirondacks. It is reported that the contract for a portion of the line has been let to J. B. Westbrook, 22 William St., New York City.

***Northern Adirondack.***—It is probable that this railway, which now runs from Moira to Tupper Lake, N. Y., will be extended during the coming summer to Cranberry Lake and Beaver River, and ultimately to North Lake and Prospect, N. Y.

***Dayton, Fort Wayne & Chicago.***—This company operating 262 miles of railway, which was sold at foreclosure last January, has been reorganized and the road will be operated in the future by two separate companies. The Cincinnati, Dayton & Southern R. R. Co. will operate the line from Dayton to Ironton, O., and the Cincinnati, Dayton & Chicago R. R. Co. will operate the division from Dayton to Delphos, O. General offices, Dayton, O.

***Lancaster, Oxford & Southern.***—This company has filed articles of incorporation in Maryland. It is an offspring of the Peach Bottom R. R. Co., and proposes to build lines from White Rock to Quarryville, Pa., 9 miles, and from Oxford, Pa., to Singerly, Md., 13½ miles, connecting that road with the Philadelphia & Reading and the Baltimore & Ohio railways. The surveys for these lines have been made, right of way secured, and construction will begin soon. S. C Slaymaker, Lancaster, Pa., Chief Engineer.

***Lake Champlain & Moriah.***—Bids will be asked about April 1 for constructing a 2-mile branch of this road to mines in the vicinity of Elizabethtown, N. Y.

***Grand Trunk.***—Surveys are now being made for second track between Montreal, P. Q., and Toronto, Ont., 162 miles, and construction will begin at an early date. Second track is now being laid between Napanee, Ont., and Gananoque Junction, 43.5 miles; Trenton, Ont., and Port Hope, Ont., 35 miles, and Scarboro Junction and Port Union, Ont., 7.5 miles. McArthur Bros., of Chicago, Ill., have the contract for the first section, and Sinclair & Doheny, of Montreal, P. Q., for the remaining sections.

***Chicago & Eastern Illinois.***—The surveys for the extension of this road to Louisville, Ky., have been completed to Blue Lick, Ind.

***St. Louis, Vandalia & Terre Haute.***—An official of this company is reported as saying that it has been practically decided to extend the line from Indianapolis, Ind., to Frankfort, Ind., 42 miles.

***Pennsylvania.***—The Cambria & Clearfield R. R. Co. will issue $2,000,000 of bonds to provide for the construction of a line from Cresson, Pa., via McGee's, to the mouth of Laurel Lick Creek, about 65 miles.—The surveys have been completed for the extension of the Cumberland Valley R. R. from Loudon to Mt. Dallas, Pa., and construction, it is stated, will begin soon. The extension will be built under the name of the Harrisburg & Bedford R. R.—Bennett & Talbott, of Greensburg, Pa., have the contract for building the South Fork Branch, and will begin work at once.—The iron pier at Atlantic City, N. J., will be rebuilt at a cost of $35,000.

***Baltimore Belt.***—Plans have been accepted for the proposed passenger station at the corner bounded by Lombard, Liberty and Howard streets. About one-fifth of the excavation for the tunnel has been finished.

***Pittsburg, Akron & Western.***—An official of this road is reported as saying that an extension would be built from Akron to Mogadore, Ohio.

***Concord & Montreal.***—An effort is being made by the people along the route to secure the extension of the Suncook Valley R. R. from Barnstead to Alton Bay, N. H.

***Boston & Maine.***—This company has agreed to build a double-track railway from Stoneham to Middlesex Falls, Mass., on condition that the first named town subscribe $500,000 in aid of the enterprise.

Projects and Surveys.

***Flint City.***—The Flint City Ry. Co. has been chartered in Michigan, with a capital stock of $50,000.

***Indiana.***—A press dispatch says:

A proposition has been made by Louisville, Ky., parties to build a north and south railway through Ripley Co., provided that the people will vote a 2% tax and will give right of way and depot grounds. Madison, Ind., will be the terminus of the line.

***Michigan.***—A. E. Boone, of Zanesville, O., projector of the Black Diamond Ry. system in Ohio, Virginia and West Virginia, has a project on foot to build a railway from Bay City to Port Huron, Mich., with a branch to the Sebewaing coal fields.

***Queenstown & Niagara Ry. & Bridge Co.***—Application has been made to the Dominion Parliament, at Ottawa, Ont., for a charter for the Queenstown & Niagara Ry. & Bridge Co., with power to construct a bridge for railway and other purposes across the Niagara River at Queenstown, and to build a railway between Niagara Falls, Queenstown and St. Catharines.

***Uniontown & Lick Run.***—Chartered in Pennsylvania to build a railway from Masonton to Uniontown, Pa. John Boyle, Masonton, Pa., President. The road is projected to develop quarries owned by the projectors, and will probably be built from Masonton to Hutchinson on the Confluence & Oakland R. R., 1½ miles only.

***Mount Carmel & Natalie.***—Chartered in Pennsylvania to build a railway 6 miles long from Mt. Carmel, on the Philadelphia & Reading R. R., to Natalie. The road is projected to connect the P. & R. R. R. with the new coal fields recently secured by the P. & R. Coal Co. John R. McGinnis, New York City, President.

***Massillon & Little Beaver.***—According to press reports there is a prospect of some work being done on this road during the present season. The company was chartered in 1890 to build a railway from Massillon to East Liverpool, O., supposedly in the interest of the Pennsylvania Co.

***Indianapolis, Logansport & Chicago.***—Chartered in Indiana to build a railway from Indianapolis, Ind., to Hammond and Michigan City, Ind. Among the incorporators are E. G. Cornelius and T. E. Helwig, both of Indianapolis, Ind.

***St. Catharines & Niagara Central.***—This company will apply to the Dominion Parliament for power to increase its bonding powers $10,000 per mile; also for power to build a railway across the Niagara River, at the Falls, and connect with any railroad in the State of New York.

***Cambridge & Chesapeake.***—A company will be chartered by this name to build a railway from Cambridge to Fox Creek Md.

SOUTHERN.—Existing Roads.

***West Virginia & Pittsburgh.***—The contract has been let for the extension of this road from Sutton, W. Va., to the Gauley River, 35 miles, and work has been begun. Tracklaying has been completed to Sutton. On the Buckhannon Branch the line has been completed to Newton, and work is now in progress from that place to Florence, W. Va., 9 miles. It is expected that both of these lines will be completed this year.

***East Tennessee Land Co.***—The *Chattanooga News* says that the grading is nearly completed on the railway from Harriman, Tenn., to the mines, and that tracklaying will begin in a few days.

***Huntington & Big Sandy.***—Tracklaying has been resumed upon this West Virginia railway, and the line will be rapidly pushed to completion.

***Savannah, Americus & Montgomery.***—This company has completed 12 miles of track east and 7 miles west from Hurtsboro, Ala., on its extension to Montgomery, Ala. Grading is rapidly progressing on the remainder of the line, and it is expected that work will be completed by August.

***Ohio River.***—About 10 miles of track have been laid on the Ravenswood, Spencer & Glendale R. R. from Ravenswood, W. Va., east, and 7 miles of this is already open for freight traffic. It is expected to have the entire line completed to Spencer by July 1.

***Norfolk & Western.***—Tracklaying on the extension to Ironton, O., has been greatly delayed by bad weather, but it is now expected that the line will be completed from Ironton to Wayne C. H., W. Va., within 6 weeks.

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF FEBRUARY, 1891
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

| | Station. | Temperature. (Deg. Fah.) Average. | Max. | Min. | Range. | Wind. Velocity in miles per hour. Average. | Maxim. | Direction at time of max. velocity. | Precipitation.—Rain and melted snow. Inches. Total. | Heaviest in 24 hours. | Number of rainy days. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NORTHERN CITIES. | Northfield, Vt | 20.9 | 51 | −17 | 68 | 12.4 | 40 | S | 2.13 | 0.56 | 13 |
| | Portland, Me | 25.3 | 51 | −4 | 55 | 9.2 | 36 | S | 4.31 | 1.00 | 15 |
| | New York City | 37.5 | 61 | 13 | 48 | 12.5 | 38 | SW | 4.69 | 0.82 | 16 |
| | Pittsburg, Pa | 39.2 | 68 | 9 | 59 | 7.6 | 27 | NW | 6.09 | 1.64 | 14 |
| | Chicago, Ill | 28 6 | 58 | −8 | 66 | 19.9 | 60 | SW | 1.95 | 0.99 | 12 |
| | Omaha, Neb | 19.7 | 53 | −9 | 62 | 8.5 | 36 | NW | 1.02 | 0.35 | 7 |
| | St. Paul, Minn | 11.2 | 44 | −25 | 69 | 7.8 | 25 | NW | 1.18 | 0.42 | 11 |
| | Duluth, Minn | 12.2 | 43 | −22 | 65 | 7.2 | 34 | NW | 2.07 | 0.84 | 13 |
| | Bismarck, N. Dak | 6.4 | 48 | −23 | 71 | 10.6 | 48 | NW | 0.57 | 0.27 | 9 |
| | Average | 22.3 | 53.0 | −9.6 | 62.6 | 10.6 | 38 | ..... | 2.67 | 0.77 | 12 |
| SOUTHERN CITIES. | Washington City | 42.0 | 74 | 16 | 58 | 8.0 | 36 | NW | 4.49 | 1.10 | 15 |
| | Louisville, Ky | 41.8 | 72 | 7 | 65 | 8.6 | 40 | S | 3.94 | 0.92 | 16 |
| | St. Louis, Mo | 35.9 | 69 | 4 | 55 | 13.6 | 44 | W | 2.95 | 0.90 | 12 |
| | Savannah, Ga | 61.0 | 84 | 28 | 56 | 8.8 | 33 | NE | 2.23 | 0.67 | 13 |
| | Leavenworth, Kan | 29.8 | 67 | −2 | 69 | 7.7 | 25 | N | 1.39 | 0.76 | 6 |
| | Jacksonville, Fla | 65.6 | 86 | 31 | 55 | 8.6 | 56 | W | 0.32 | 0.17 | 6 |
| | Chattanooga, Tenn | 50.0 | 76 | 21 | 55 | 8.0 | 26 | NW | 10.30 | 2.71 | 19 |
| | New Orleans, La | 62.6 | 80 | 34 | 46 | 12.0 | 34 | E | 7.42 | 2.60 | 15 |
| | Memphis, Tenn | 47.7 | 74 | 25 | 49 | 9.2 | 30 | NW | 4.07 | 1.29 | 15 |
| | Palestine, Tex | 53.6 | 82 | 21 | 61 | 8.5 | 29 | S | 1.92 | 1.61 | 5 |
| | Average | 49.0 | 76.4 | 18.5 | 57.9 | 9.3 | 35 | ..... | 3.99 | 1 27 | 12 |
| WESTERN CITIES. | Helena, Mont | 7.0 | 45 | −24 | 69 | 5.0 | 26 | NW | 1.68 | 0.36 | 16 |
| | San Francisco, Cal | 51.2 | 61 | 40 | 23 | 8.4 | 48 | SW | 7.26 | 3.38 | 19 |
| | Salt Lake City, Utah | 30.6 | 55 | 3 | 52 | 6.4 | 36 | SW | 0.76 | 0.28 | 10 |
| | Denver, Col | 26.9 | 61 | −6 | 67 | 6.9 | 36 | NE | 0.27 | 0.19 | 5 |
| | Yuma, Ariz | 55.2 | 74 | 32 | 42 | 6.7 | 40 | N | 2.53 | 1.24 | 6 |
| | Santa Fé, N. Mex | 29.6 | 50 | −6 | 56 | 7.0 | 36 | NW | 1.91 | 0.78 | 11 |
| | Average | 33.4 | 58.0 | 6.5 | 51.5 | 6.7 | 37 | ..... | 2.40 | 1.04 | 11 |

The grading between Wayne C. H. and Elkhorn is being rapidly pushed.—Work has been begun relaying the Shenandoah Valley R. R. with heavier rails.— Construction is in progress on a short branch on Little Town Creek, and the construction of another up Russell's Creek is contemplated.

Projects and Surveys.

***Memphis & Atlantic.***—F. M. Abbott, of West Point Miss., President, writes us as follows:

The surveys have been completed for this railway, which is to run from Memphis, Tenn., via Oxford, Houston, West Point and Columbus Miss., to Tuscaloosa, Ala., 224 miles. The earthwork will average about 8,000 cu. yds. per mile: maximum grade, 40 ft. per mile, and maximum curve 4°. About two-thirds of the right of way has been secured, and $500,000 in town and county bond subscriptions to capital stock obtained. Maj. Belton Mickle, West Point, Chief Engineer.

***Birmingham, Mobile & Navy Cove Harbor.***—Additional reports state that arrangements are being made to commence work upon this road at an early date, as stated in our issue of last week.

***Georgia Northern.***—Application will soon be made for a charter to build a line of railway from Dalton or Cohutta junction, Ga., through the counties of Whitefield Murray, Gordon, Gilmer and Pickens, to Ball Ground, Cherokee Co.

***Hartford & Fordsville.***—The prospects for an early commencement of work on this Kentucky railway seem good. The road is to run from Hartford to Fordsville, Ky., 19 miles. President, T. J. Smith, Hartford, Ky.

***West Virginia.***—A company will be formed soon to build a railway from the Kanawha & Michigan R. R. up Two Mile Creek to the Jackson Co. line, W. Va. W. B. Hayes, of New York City, is interested.

***Georgia.***—A company has been formed to build a logging road from Tallapoosa, Ga., south. J. W. Hyatt, 11 Wall St., New York City.

***Wilmington & Southern.***—This company, which was chartered at the last session of the North Carolina Legislature, proposes to build a railway from Wilmington, N. C., to Southport, N. C. Surveys have already been made.

NORTHWEST.—Existing Roads.

***Missouri Pacific.***—It is announced that work will be resumed on the extension to Plattsmouth, Neb., at an early date.

***Northern Pacific.***—A press dispatch from Pierre, S. Dak., says:

Citizens of Pierre at a meeting recently held formally instructed the directors of the Duluth, Pierre & Black Hills R. R. to complete the grading on that road from Pierre to Aberdeen. Financial support was guaranteed. Forty-five miles of the road were graded last fall and there are 84 miles to be completed.

***Ohio & Mississippi.***—The surveys for the proposed extension of this road from Effingham, Ill., to a point on the Ohio River opposite Paducah, Ky., have been completed. The line will be 51 miles long.

Projects and Surveys.

***United States Railway & Equipment Co.***—Chartered in Illinois to build and equip railways. Incorporators: Wm. Armstrong, Frank B. Dyche and Lawrence Harmon.

SOUTHWEST.—Existing Roads.

***Fort Worth & Rio Grande.***—The contract for the extension of this road from Comanche to Brownwood, Tex., will be let in a few days.

***Waco, Lampasas & Llano.***—Work has been suspended on this Texas railway, owing, it is stated, to lack of funds. About 16 miles of the grading had been completed.

Projects and Surveys.

***Fort Scott, Kansas City & Northern.***—At a recent meeting of the stockholders of this company the following officers were elected: President, A. A. Harris; Vice-President, John Crow; Treasurer, J. P. Chenault, and Secretary, S. P. Mosher. The company proposes to build a railway from Fort Scott, Kan., to Amoreth, Mo., 27 miles.

***Kansas City, Bentonville & Southeastern.***—A press dispatch says:

The contract has just been signed for the completion of the Kansas City, Bentonville & Southeastern R. R. giving Bentonville, Ark., a direct short connection with Kansas City and all points north. The engineers will begin on Wednesday to run the line by way of Springdale on the Bald Knob, from which point the Missouri Pacific has a road running into Memphis. This will give the Missouri Pacific the most direct and shortest line from Kansas City to Memphis.

ROCKY MT. AND PACIFIC.—Existing Roads.

***Centralia Belt.***—Tracklaying has been commenced on the belt railway at Centralia, Wash. This road is being built to connect the coal fields lying east of the town with the various railroads centering there, and with the mills at Chehalis.

***Southern Pacific.***—It is reported that tracklaying has been completed on the Tracy & Armona branch to the north bank of Deep Creek, about nine miles north of Armona, Cal., and that tracklaying is now in progress from Armona north. It is expected that the road will be completed from Armona to Tracy by April 1.

Projects and Surveys.

***Deep Creek.***—It is reported that work has been commenced on this Utah railway. The road is projected to run from Salt Lake City, Utah, west to the mineral fields in the vicinity of Deep Creek. The company is practically a reorganization of the Wyoming, Salt Lake & California R. R. Co., which proposed to build a railway from Evanston, Wyo., west via Salt Lake City to the Nevada line, and which did a small amount of grading on its line west from Salt Lake City in 1889.

***Goble & Astoria.***—Surveys have been begun for a railway from Goble, Wash., to Astoria, Ore., 58 miles.

***Mt. Tabor & Eastern.***—A railway company by this name has been formed in Oregon to build a railway from Portland, Ore., east to the Cascade Mts. Among the incorporators are: J. T. Ross, B. Lamberson, L. W. Wallace and others.

***Nevada & Utah Air Line.***—Chartered in Nevada to build a line of railway from Reno, Nev., to Pioche, Nev.

***Sidney & Southwestern.***—Chartered in Washington to build a railway from near Tacoma, north to Sidney, Wash.

***Butte Creek & Molalla.***—Chartered in Oregon to build a railway from Salem, Ore., via Mount Angel, Butte Creek and Scott's Mills to Molalla, Ore. Among the incorporators are: R. H. Scott, Robert Thompson and F. M. McCleran. Principal offices, Butte Creek, Ore.

FOREIGN.

***Mexico.***—All arrangements are reported completed for building the proposed railway from Deming, N. M., south to Topolobampo, with branches to Guaymas, Chihuahua and Yaqui, a total distance of 1,250 miles. About 70 miles of the line are now graded, ready for tracklaying, and 100 miles additional are to be finished this season, and the remaining distance within two years. The road is subsidized by the Mexican Government to the amount of $14,800 per mile in addition to granting bonds on it amounting to $25,000 per mile and stock to the amount of $25,000 per mile additional. John W. Young, of Salt Lake City, Utah, has the contract.

## CITY TRANSIT.

**Electric Railways.**—New lines or extensions of existing systems are reported as probable in the following places: Holbrook, Mass., address M. E. Peterson, Brockton, Mass.; Belfast, Me.; Sheffield, Ala.; Columbia S. C., address J. P. Thomas, Natick, Mass.; Riverside, O.; Towanda, Pa.; Warren, O., address J. P. Hoefgen, Johnstown, Pa.; Iowa City, Ia.; Oakland, Cal.; Calais, Me., address L. G. Downes; Duluth, Minn.; Butte, Mont., address the Metropolitan Electric Ry.; Wilmington, Del.; Brownwood, Tex., address C. Vincent; Altoona, Pa.; Appomattox, Va.; Eugene, Ore.; Syracuse, N. Y., address the Consolidated Street Ry. Co.; Albuquerque, N. Mex., address J. Boehm, Denver, Colo.; Milwaukee, Wis., address Washington Becker; Martinsburg, Va., address J. B. Wilson; Oakland, Cal., address the Oakland & Berkely Rapid Transit Co.; Louisville, Ky., address the Louisville Ry. Co.

***Boston, Mass.***—The Lynn Belt Line Street Ry. Co., the Thomson-Houston Electric Co and the North Shore Electric Ry. Co. are interested in a project for an electric railway running from Franklin Park, in this city, through Winthrop Junction, Beachmont, Crescent Beach and Oak Island to Lynn, a distance of 13 miles.

***Ransomville, N. Y.***—It is reported that nearly all the necessary right of way has been secured for a line from Rochester, through Wright's Corners, Ransomville and Youngstown, to Lewiston.

***Chimney Rock, Va.***—A company has been formed here to build a road from Tryon City, via Chimney Rock and Rutherfordton, to Asheville. The President is F. Reynolds; Secretary, J. S. Williams, and Treasurer, J. Ashworth.

***Wilmington, N. C.***—It is reported that the Wilmington Street Ry., operating 4 miles of horsecar lines, has been sold to E. L. Hawks, of Winston, N. C., who will build 5 miles of new lines and operate the road by electricity.

***Nashville, Tenn.***—It is reported that D. B. Cooper, G. H. Whitworth, P. P. Pickard have chartered a company to build an electric line here.

***Bristol, Tenn.***—The Electric Engineering & Construction Co. is reported to have bought the Bristol Street Ry. for the purpose of changing it to an electric line.

***Cincinnati, O.***—Plans for a large power-house for the Cincinnati-Mount Auburn Electric Ry. are being prepared by Geo. Hornung, of this city, the Consulting Engineer of the line.

***Minneapolis, Minn.***—It is reported that about 70 miles of new track will be laid this year by the Minneapolis Street Ry. Co. Carr & Smith are the Engineers.

***Los Angeles, Cal.***—Plans and specifications for the power-house and 12 miles of track of the Belt Electric R. R. have been finished and bids are invited.

**Horse Railways.**—New lines or extensions of existing systems are reported as probable in the following places; Charlottesville, W. Va., address W. J. Ficklin; Savannah, Ga., address the Savannah & Isle of Hope R. R. Co.; Shendun, Va., address J. A. Garrett, of Staunton, Va.; Louisville, Ky., address C. O. Warren; Houston, Tex. address the Moss Collar, Bagging & Cordage Co.; Oakland, Cal., address the Oakland Consolidated Street Ry. Co.

***Martinsburg, W. Va.***—The City Council has granted to S. W. Walker, J. B. Wilson and G. M. Bowers a franchise for constructing a horse railway in this city. The franchise requires that ½% of the net proceeds be paid to the city, and that the company begin work within 40 days from the passage of the ordinance.

***Omaha, Neb.***—The City Council has given permission to the Metropolitan Street Ry. to build a new line. Work must begin by the middle of July and be finished before July 1, 1892.

**Elevated Railways.**—***Chicago, Ill.***—The South Side Elevated R. R. has petitioned for amendments to its franchise by which it will be permitted to materially change some of its proposed lines.

***St. Louis, Mo.***—S. F. and T. A. Scott have prepared plans for an elevated railway, and a company is said to be forming to build the line.

**Dummy Railways.**—***Waco, Tex.***—Prices of material and equipment for a 7-mile freight and passenger railway are wanted by J. Jones.

***Rusk, Tex.***—The directors of the Rusk & New Birmingham Street Car Co. have decided to operate the line by dummy engines rather than horses, as at present.

***Walla Walla, Wash.***—O. R. Ballou and W. Matthews have secured the right of way for a dummy line to Milton, including lands for stations here and in that town.

**New Companies.**—Anna & Jonesboro Electric Light, Street Ry. & Power Co., Anna, Ill.; capital stock, $20 000; incorporators, F. S. Dodds, C. L. Otrich, J. E. Luskin and others. Vernon Park Ry. Co., Savannah, Ga.; Secretary, O. T. Rogers. Flint City, Mich., Ry. Co.; capital stock, $50,000. People's Surface R. R. Co., Niagara Falls, N. Y.; capital stock, $60,000. Appalachian Building & Improvement Co., Charlestown, W. Va.; capital stock, $120,000; incorporators, H. H. Jones, of Doehill, Va.; J. Hilles, of Hausel, W. Va.; J. J. Hines, of McDowell, Va.; and others. Cañon Traction, Light, Power & Land Improvement Co., Cañon City, Col.; capital stock, $1,500,000; Secretary, B. B. Schock. Tuskaloosa, Ala., Street Ry. Co.; capital stock, $100,000; incorporators, J. H. Fitts, S. F. Alston, G. A. Searcy and others. Arcadia, Fla. Street Ry. & Investment Co.; capital stock, $1,0,000. Monmouth, Ill., Motor Street Ry. Co.; capital stock, $30,000.

## HIGHWAYS.

***Massachusetts.***—The Legislative Committee on Roads and Bridges has taken up the subject of improving the highways. The League of American Wheelmen ha petitioned for the appointment of a commissioner to have general supervision of the highways of the state, to collect statistics bearing on the science and to give advice free to all town officials who may wish to consult him. After the towns realize the benefit of better roads, the demand for them will increase. A bill has been submitted for this purpose. Mr. Albert F. Noyes, City Engineer of Newton, favored the appointment of a commissioner for the sake of consultation by officers of cities and towns. He had found it difficult to get necessary information. It could be gained only by much inquiry, visitation of other cities and towns, and waste of time. Mr. John W. Porter, of Danvers, said that his town kept increasing its road appropriations, but the roads grew poorer. He urged that there be a head to the highway department of the state. This is done in European countries, and they have far better roads at less expense than we in this country.

***Rhode Island.***—The North Kingstown Improvement Society, of Wickford, has recommended that the town appropriate $25,000 for road work this year, $15,000 to be expended on road machinery and $10,000 on the roads, under the direction of a competent road commissioner; also that $10,000 be appropriated annually for the improvement of the roads.

## BRIDGES, TUNNELS AND CANALS.

**Bridges.**—***Indianapolis, Ind.***—The Union Railway Co. has submitted the specifications for the Virginia Ave. viaduct to the city engineer for approval. They call for the approaches and 502 ft. of iron superstructure supported on iron or steel columns. The superstructure must consist of 28 spans of riveted plate girders, ranging in length from 37 ft. 1 in. to 74 ft. 7. in. Two roadways, 26 ft. each, and 2 sidewalks, 9 ft. each; roadway to be paved with pine blocks, and sidewalks with artificial or natural stone. All parts of the structure shall be of wrought iron or steel. The floor system shall consist of riveted plate girders. Double-track street railway tracks are to be provided for in designing floor beams and stringers, 12 ft. c. to c. of tracks. There will be 2,000 sq. yds. of roadway paving and 1,000 sq. yds. of sidewalk paving. The retaining walls will be 2 walls 440 ft. long, 2 walls 290 ft. long, 2 breast walls 90 ft. long and 25 foundations for iron columns. There will be 2,900 cu. yds. of earth and sand excavation, 1,250 cu. yds. of concrete, 2,900 cu. yds. of stone masonry, class A, and 1,400 of class B; 1,870 cu. ft. of stone coping, 12 in. thick, and 720 of 18 in. thick; 18,000 cu. yds of earth or sand filling will be placed between the retiring walls; 2,500 cu. yds. of macadam paving for roadway, 3,7.5 sq. yds. of brick pavement for sidewalks, and 1,830 lin. ft. of curbing.

***Cumberland, Md.***—An iron bridge will probably be built at Baltimore St.

***Richmond, Va.***—The Edge Moor Bridge Co. has completed the bridge for the Northside Land & Imp. Co. Length, 1,185 ft. 5 in.; 34 ft. roadway; 6 ft. sidewalk. Cost, $86,000.

***Ceredo, W. Va.***—The Big Sandy Bridge Co. will build a bridge across the Ohio River at this point. S. S. Vinson, President.

***Atlanta, Ga.***—Bids will be asked April 1 for the proposed Forsyth St. bridge. It will consist of two 120-ft spans, supported on iron piers; approximate cost, $60,000.

***Omaha, Neb.***—The Missouri River Bridge Company, of which Arthur S. Potter is manager, will erect a combination railroad and wagon bridge to cost $1,000,000.

## WATER-WORKS.

### NEW ENGLAND.

***Belfast and Northport, Me.***—The proposed works for Northport consist of the extension of the mains of the Belfast Water Co. to supply cottages at the Northport Camp Ground. It seems probable that the town will take hydrants if the extension is made.

***Goffstown, N. H.***—J. C. Gowing, Boston, Mass., is interested in the water-works project.

***Salem, N. H.***—It seems probable that the bill incorporating the Salem Water-Works Co., noticed last week, will be repealed or amended so that the company will be limited to supplying Salem and Salem Depot.

***Fall River, Mass.***—The question whether the city has the right to the use of water from Watuppa Lake without compensation to mill-owners is again in the courts.

***Lowell, Mass.***—The Lowell *Mail* is of the opinion that filtration should be considered rather than the obtaining of a supply from New Hampshire or other remote localities.

***Malden, Mass.***—It is reported that an additional or new supply from Martin's Pond, North Reading, is under consideration. The cost is estimated at $500,000.

***Marblehead, Mass.***—The question of a new supply has been indefinitely postponed by a vote of 117 to 27. The present supply is from driven wells.

***Orange, Mass.***—W. L. Grant informs us that surveys for new works are being made, and that works including 15 to 18 miles of mains will probably be built this year. The New Home Sewing Machine Co. built works here in 1875 and in 1888 were supplying about 100 families.

***Quincy, Mass.***—There will soon be a legislative hearing on the petition to allow Quincy to construct independent works. The State Board of Health recommends further investigations before deciding upon a source of supply, and states that the source of the present company's supply is ample, but that it contains too much organic matter. Much of the latter could be kept out by sanitary protection.

***Somerville, Mass.***—The following is from H. L. Eaton, City Engineer:

An ordinance has passed the City Council and been referred to the committee on water instructing the latter to "consider the expediency of the city owning its water supply by the purchase of the Mystic Works [from Boston], or otherwise," and to report to the Council as soon as practicable.

[Somerville now owns its distributing system, but purchases its water supply from Boston. The latter city collects all water rates and pays the city of Somerville a rebate of 50%. For further particulars see the "Manual of American Water-Works for 1889-90."—ED.]

***Providence, R. I.***—The amended act to incorporate the American Water-Works Co., has passed the State Senate. For further particulars see these columns in our issue of March 14.

***Woonsocket, R. I.***—The Council has concurred in a report recommending the procuring of legislation authorizing the city to issue $100,000 bonds for the proposed improvements, or some of them recently noted, namely: a new 5,000,000-gall. pump, boiler, force main and large storage tank.

***New Britain, Conn.***—The following is from D. A. Harris, Superintendent:

The city intended to lay this year a 24-in. cast iron supply main 2¼ miles long to replace a line of 12 and one of 8-in. wrought iron and cement pipe; also to build a new and larger dam. It now seems that this may be impossible, since a $100,000 bond issue is necessary, and is not likely to be authorized by the Legislature, owing to its failure to transact business. A line of 8-in. cement pipe 1,600 ft. long, within the city, will be relaid with 12-in. iron, and some extensions on new streets will be made.

***New Haven, Conn.***—The proposed purchase by the city of the company's works will probably not be carried out this year, it being too late to secure the necessary authority.

### MIDDLE.

***Rome, N. Y.***—W. C. White, Chairman of the County House Water Supply Committee, wishes prices on 200 tons of pipe to be used in laying a main to the County House.

***Wurtsboro, N. Y.***—Estimates for works are being made under the direction of A. Case.

***Brigantine, N. J.***—The Brigantine Water Co. has been incorporated by E. C. Miller, Philadelphia, and J. H. and H. E. Doughty, of Haddonfield, N. J.; capital, $100,000, of which $10,000 is paid in. Principal place of business, Camden.

***Carbondale, Pa.***—A. Pascoe, Secretary, informs us that some old pipe will be replaced by new.

***Lancaster, Pa.***—E. F. Frailey, Superintendent, has sent the following:

The city intends to build a reservoir with a capacity of not less than $20,000,000 galls., and to put in another pump, provided a $150,000 loan will cover the cost of both. The reservoir must come first.

***Lower Merion, Pa.***—The Lower Merion Water Co. has asked the Court for an extension for another five years of the time for completing its works. A. A. Hirst, H. W Barrett and others have filed protests against the renewal, on the ground that the franchise is held for speculative purposes. There is talk of organizing another company.

***Newport, Pa.***—A resident informs us that about three months ago Philadelphia parties secured a charter for a company, but nothing has been done.

***McSherrystown & West Hanover, Pa.***—R K Martin, Baltimore, Md., has been investigating the possibilities for works to supply these places. It is said that a supply of spring water can be obtained sufficient for these villages and for an additional supply to Hanover.

***Scottdale, Pa.***—The Citizens' Water Co. has begun the construction of a reservoir at Mt. Vernon. It will have a capacity of 80,000,000 galls., and will be formed by a dam 40 ft. high, 134 ft. thick at the bottom and 14 ft. at the top.

***Wayne, Pa.***—We are informed that a new artesian well is to be sunk.

### SOUTHERN.

***Front Royal & Riverton, Va.***—The following is from H. H. Downing, President of the Front Royal & Riverton Improvement Co.:

The Front Royal Water Co. is being formed to build works to supply Front Royal and Riverton, which are one mile apart, and have a combined population of about 2,000. It is proposed to bring water by gravity from a mountain creek, which will afford ample head. The estimated cost is $35,000. Subscriptions for about $20,000 of stock are being secured. Front Royal has agreed to pay about $1,000 annually for hydrants. It is expected that contracts will be let about June 1.

***Fairmont, W. Va.***—We are informed that a city ticket has just been elected, every member of which is pledged to the passage of an ordinance to bond the city for $40,000 for water-works.

***Hickory, N. C.***—Hartford, Heburt & Co., Designing Engineers, of Chattanooga, Tenn., inform us that the works for which we stated last week that bonds had been voted will consist of a supply pumped from wells to a stand-pipe; estimated cost, $25,000. Population, 3,500.

***Newberry, S. C.***—The following is from J. K. P. Goggans, Mayor:

At a citizens' meeting held March 19 the council was instructed to procure propositions for the construction of both water works and electric lighting plants.

***New Berne, S. C.***—It is reported that a franchise has been granted to G. E. Ladshaw, and others, of Spartansburg, S. C.

***North Wilkesboro, N. C. (Wilkesboro P. O.).***—The Winston Land & Improvement Co. has projected water and electric lighting works.

***Atlanta, Ga.***—The Chattahochee Water & Power Co. has been organized with G. W. Adair, President, and W. I. Zachry, Secretary. The *Constitution* has the following regarding the company:

The company is incorporated with a minimum capital stock of $1,000,000, for the purpose of dealing in real estate, water rights and privileges, constructing and operating water-works, electric lights and power plants, and supplying cities, communities, manufacturing enterprises, etc., with water, electric lights and motive power for all purposes. The company controls valuable lands and water rights on the Chattahoochee River, their water power being of such fall and force as to make it the best in the state.

A recent break in the force main caused the city to be without water for several hours, and increases the demand for securing the proposed additional supply as speedily as possibly.

***Gainesville, Ga.***—Works have been completed, including about 5½ miles of mains.

***Madison, Ga.***—It is reported that a franchise will soon be granted. Address Mayor Butler.

***Ozark, Ala.***—The council has authorized the expenditure of money for works.

***Hickman, Ky.***—George Warren informs us that bids are wanted until April 20 by J. W. Cowgill, Mayor, for $20,000 of 6%, 30-year bonds in denominations of $500. The bonds will be dated May 1, 1891.

***Stanford, Ky.***—The following is from J. W. Hayden, City Clerk:

The Stanford Water-Works Co. will begin the construction of works April 1. The supply will be pumped from springs to a stand-pipe. Estimated cost, $25,000. Population, about 3,000. J. P. Peyton is Secretary and Treasurer, and Sturtevant Bros. build the works.

### NORTH CENTRAL.

***Bridgeport, O.***—The following is from J. M. Gardiner, of Gardiner & McGlasson, of Ashland, Ky., Engineers for the works:

The Bridgeport Water Co. expects to let contracts for works about May 1. It is proposed to pump water from the Ohio River to a reservoir. The works are estimated to cost $85,000. T. D. McGlasson is President. Population, 5,000.

***Greenfield, O.***—The following is from H. L. Dickey, Chairman of Water Committee:

The people have voted, 509 to 20, in favor of $35,000 of water bonds. The works will be built, with G. P. Martin, Xenia, O., contractor. There will be four miles of mains.

***Toledo, O.***—It is reported that meters are being put in for all consumers.

***Zanesville, O.***—R. M. Saup, Superintendent, informs us that owing to the refusal of Spitzer & Co., Toledo, to take the $50,000 of bonds in accordance with their offer the proposed improvements will be postponed.

***Bloomington, Ind.***—The following is from P. B. Greers:

A franchise has been granted to Jesse W. Starr, Philadelphia, who must begin the construction of works prior to June 3. The city will pay an annual hydrant rental of $3,000. Probably the supply will be pumped to a stand-pipe, and it is likely that the former will be difficult to obtain. Population, 5,000.

***Huntington, Ind.***—At the recent water-works test there was a break in the main pipe line which necessitated several days' time for repairs. Much of the trenching was through a flinty stone.

***Mishawaka, Ind.***—We are informed that pipe-laying has just been begun and that the works will be in operation May 1. Kalamein pipe, Gordon pumps, Babcock & Wilcox boilers, and Ludlow valves and hydrants are being used.

***Portland, Ind.***—J. A. M. Adair, City Clerk, informs us that the people have just voted, by over 100 majority, in favor of works. It is reported that the works will cost about $20,000.

***Jackson, Mich.***—The following is from Edward Knight, Mayor:

On April 6 the people will vote on the issuance of $50,000 water bonds, $15,000 to be used to bring water into the city from artesian wells and $35,000 for extensions to the mains.

***Mancelona, Mich.***—The following is from the Mancelona Manufacturing Co.:

We are organizing a water company here, but the organization is not yet complete.

***Saginaw, Mich.***—Two bills have passed the House, one authorizing the city to vote on the borrowing of $100,000 to obtain a supply from the Tittabawassee River, the other to vote on borrowing $25,000 [probably] to connect the east and west pumping stations, Saginaw and East Saginaw having been consolidated recently.

***Alton, Ill.***—A contract has been let for works to supply the country residence and grounds, above the city, of Mrs. Lucy N. Ames; estimated cost, $15,000.

***Collinsville, Ill.***—The following is from J. L. B. Wadsworth, chairman Special Water Committee:

The city proposes to build works. Probably water will be pumped from a deep well and a stand-pipe, but this has not been decided. It is thought that water can be obtained in white sandstone at a depth of 400 to 500 ft. Population, 3,690.

***Hinsdale, Ill.***—The time for receiving bids for works has been extended to April 13. For particulars see p. xix.

***Polo, Ill.***—H. H. Thomas, Mayor, has sent the following:

A well is being sunk which it may take several months to finish. When the well is completed works estimated to cost $20,000 will be built. The well will be from 1,000 to 2,000 ft. deep, and water will probably be pumped to a stand-pipe. Population, 2,000.

***Centerville, Ia.***—D. W. Hunt, Fort Dodge, informs us that arrangements for works are being made, but that nothing definite has yet been decided upon.

***Ida Grove, Ia.***—F. A. Lusk, Chairman, informs us that the town expects to add ½ or ¾ miles of mains this year.

***Excelsior, Minn.***—The following official information has been received:

Plans and specifications for gravity works have been submitted to the town council by Carr & Smith, Minneapolis; estimated cost, $18,000. Population, about 1,000. The town has been authorized to issue bonds to pay for works, but a franchise may be granted instead.

***Worthington, Minn.***—Water bonds to the amount of $15,000 have been voted. D. Shell is President of the council.

***Wellington, Kan.***—J. M. Thralls, Superintendent, informs us that the dam across Slate Creek will be raised 7 ft. this year.

***Broken Bow, Neb.***—F. H. Young informs us that the company expects to lay one mile of mains this year.

***Omaha, Neb.***—It is reported that a new Allis pumping engine is being erected at the Florence station, and that the pipe for the new 48-in. main from the station to the city is being hauled.

***Flandreau, S. Dak.***—A petition is being circulated asking the Village Council to submit to popular vote the question of issuing bonds for works.

***Scotland, S. Dak.***—A. D. Ardery, Superintendent, informs us that the mains may be extended into the residence portion of the town. At present water is supplied for fire protection only.

### SOUTHWESTERN.

***Kirkwood, Mo.***—The trustees have refused to accept the offer of the Sunset Hill Water, Light & Power Co. of 50 hydrants at a rental of $50 each. The company has since offered to rent 40 hydrants at the same rate. It is reported that the company proposes to operate between the Meramec River and the city of St. Louis, and that their main line will extend through Kirkwood.

***Macon, Mo.***—Works have been completed.

***Webster Groves, Mo.***—The Webster Groves Water-Works Co. has begun to lay its mains.

***Ballinger, Tex.***—The council has accepted plans and specifications for works.

***Cleburne, Tex.***—A new pump is being added and new mains laid.

***Ennis, Tex.***—J. S. Thatcher, Dallas, Tex., Engineer for the reservoir mentioned below, has sent the following:

A proposition to put in a $60,000 water-works, electric

lighting and ice plant has been accepted at a citizens' meeting. The supply will be from a large storage reservoir already built.

*Tyler, Tex.*—Surveys are being made for a supply main from the new reservoir to the city. It is reported that the reservoir is 6 miles from the city and is fed by springs.

*Uvalde, Tex.*—W. W. Collier, Secretary and Treasurer, has sent the following:

The city has granted a franchise to the Uvalde Water Supply & Power Co., and M. P. Kelley is President of the company and R. B. Copeland Constructing Engineer of the works.

*Waxahachie, Tex.*—It is reported that the supply of the company will be from springs west of the town.

*Boulder, Col.*—The new reservoir has been completed

PACIFIC.

*Ballard, Wash.*—The Town Council is still considering the subject of water supply. The sentiment in favor of town ownership is strong, and it is probable that the small plant of the West Coast Improvement Co. will be incorporated with the new system.

*Dayton, Wash.*—The following is from C. F. Miller, City Clerk:

The people have voted, 7 to 1, in favor of issuing $75,000 of bonds for works. It is proposed to introduce a gravity supply from a supply well two miles from a town, to let contracts May 1, and to begin construction June 1. The project includes a reservoir. J. H. Day is Chairman of the Water Board and A. L. Adams, Pendleton, Ore., has made surveys. Population, 2,000.

Since the above was received bids have been invited as follows:

Sealed proposals will be received until May 1, 1891, for furnishing all pipes, stop gates, fire hydrants, and specials, to be used in putting in a $75,000 system of waterworks; also for laying said pipe, setting gates and hydrants, and taking up old pipes; also for one reservoir, supply well, and aqueduct. All proposals must be addressed to the Board of Water Works, J. H. Day, Chairman. Specifications and blank forms will be furnished on application to C. F. Miller, City Clerk.

*Seattle, Wash.*—Edgar Bryan, Secretary of the Union Water Co., has written to the Board of Public Works to know if they would consider a proposition to rent the company's works, which includes over 12 miles of mains, with the privilege of purchase by the city.

*East Portland, Ore.*—Bids are wanted by the city until April 13, for $250,000 of 5% 30-year bonds, to be used in acquiring water-works. The present bonded debt is $25,000, which is partially offset by a $10,000 sinking fund.

## ARTESIAN WELLS.

*Monroe, La.*—It is reported that the Boone Well Co., Memphis, Tenn., is sinking a well here.

*Belton, Tex.*—A flow estimated at 500,000 galls. per day has been struck at a depth of 1,015 ft. It will be added to the water supply.

*Hempstead, Tex.*—The Houston & Texas Central Ry. Co., it is reported, will sink a well here to supply their locomotives. It is also reported that the town will join in the work, and that water can be found at a depth of 40 to 60 ft.

## IRRIGATION.

*Canon City, Col.*—A ditch about three miles long will be dug to irrigate land in Lincoln Park, and to furnish drinking water in South Cañon.

*Grant's Pass, Ore.*—A company is proposed to construct a ditch from Rogue River to irrigate 15,000 acres of land; estimated cost, $200,000.

*San Bernardino, Cal.*—The Arrowhead Reservoir Co. has been incorporated under the laws of Kentucky; capital, $1,000,000. The company proposes to construct reservoirs in the mountains near San Bernardino to store water for use in irrigating the lands in the valley. The incorporators are James M. Gamble, James E. Mooney, Charles Kilgour and others, of Cincinnati, O., and L. M. Holt, of California.

*Menan, Idaho.*—The Long Island Irrigating Co. has filed articles of incorporation. The company proposes to take water from the North Fork of the Snake River in Bingham Co. The capital stock is $15,000. Ephraim Scott, George Eames, Josiah Scott, Hyman E Poole and John T. Caldwell are the Directors. The canal has been in operation for 9 years.

*New Companies.*—The following companies have been incorporated:

Lane County Irrigation Co., Cheyenne Township; F. W. Shultz, S. J. Smith, Directors; capital, $20,000. High Line Ditch & Land Co., Grand Junction, Col.; capital, $100,000. Bosque Redondo Irrigation Co., Fort Sumner, N. M.; capital, $50,000. Cottonwood, Sulphur Spring and Kelly Creek Irrigation Cos., Lakeview, Ore., the first with a capital of $2,500, the last two, $2,000. Also at Lakeview, Dry Creek Irrigation & Water Co., by G. C. Turner and W. A. Massingill, with a capital of $5,000.

## SEWERAGE AND MUNICIPAL.

**Sewers.**—*Brattleboro, Vt.*—It is proposed to complete the sewer system this year.

*Great Falls, N. H.*—About two-thirds of the sewerage is completed, and work will soon be recommenced.

*Beverly, Mass.*—Plans for a system of sewers have been submitted by Mr. E. M. Bowditch, of Boston, and will be acted upon by the town in April.

*Springfield, Mass.*—Mr. Rudolph Hering is making an investigation of the sewerage system.

*Westfield, Mass.*—A sewerage system is being put in under the supervision of Mr. L. F. Thayer, City Engineer.

*Le Roy, N. Y.*—About one mile of sewer has been built and there is a movement for a sewerage system.

*Little Falls, N. Y.*—About a mile of sewers will be built this year, and it is proposed to construct a sewer on the south side of the river.

*Salem, N. J.*—About 2,000 ft. of sewer pipe were laid last year, and 2,500 will be laid this year. The Waring system has been adopted, the plans being prepared by Mr. Gaskel, of Mt. Holly, N. J., and approved by Col. Waring.

*Passaic, N. J.*—The Mayor has vetoed an ordinance to build sewers in Passaic Bridge and the Third Ward on the ground that, if Newark and Jersey City should win the pending sewer suit, the cost would fall upon the city at large, as an assessment would not stand with the outlet into the river blocked by an injunction.

*Orange, N. J.*—At a special meeting of the Common Council the sewerage and drainage ordinance was passed on its third reading. Mr. C. P. Bassett, of Newark, N. J., is the Engineer.

*Montclair, N. J.*—A proposition has been made to the Orange Sewerage Committee by Montclair and Bloomfield.

*Erie, Pa.*—An ordinance has been passed appropriating $10,000 toward the cost of an intercepting sewer, the total cost of which will be between $40,000 and $56,000.

*Clarksville, Tenn.*—Bonds for $160,000 are to be issued for sewerage purposes.

*South Pittsburg, Tenn.*—It is proposed to issue sewer bonds for $20,000.

*Salisbury, N. C.*—A sewerage system is proposed, and bonds are to be issued.

*Wilmington, N. C.*—Mr. Rudolph Hering, of New York, has submitted a preliminary report on the proposed sewerage system.

*Florence, S. C.*—The Mayor favors the idea of engaging an engineer to lay out a complete drainage system.

*Atlanta, Ga.*—The Council has adopted an ordinance providing for the construction of sewers to cost $15,000.

*Savannah, Ga.*—An ordinance has been introduced providing for the organizing of a drainage commission.

*Bridgeport, Ala.*—Plans for a system of sewerage are reported as being prepared by D. L. Smith, of New York, N. Y.

*Alliance, O.*—Sewers are under consideration. For particulars address the City Engineer.

*Piqua, O.*—The city has just commenced the construction of sewers.

*Toledo, O.*—Sewer extensions will be made this year at a cost of about $100,000. Half of the work is already under contract.

*Cicero, Ill.*—The amended plans of Mr. Maynard, the Engineer, have been adopted. There will be an outfall sewer 8 ft. diameter. The estimated cost is $230,000 and $160,000 for the two districts.

*Escanaba, Mich.*—The contract for building the crib and laying pipe thereto for sewer outlet has been awarded to J. B. Moran for $1,250; $250 for manhole and laying iron pipe on shoe, $2.50 per ft. for vitrified pipe. Mr. C. T. Loweth, of St. Paul, Minn., Consulting Engineer.

*David City, Neb.*—A system of sewerage is contemplated. For particulars address the David City Improvement Association.

*Leadville, Colo.*—The Leadville Sewer Co. expects to lay 2,500 ft. of sewers this year.

*Carson City, Nev.*—A bill has passed the Legislature authorizing the city to issue $25,000 in bonds for a sewerage, and proposals will shortly be advertised for laying a sewerage system with vitrified ironstone pipe.

*Fairhaven, Wash.*—The city will probably issue bonds for $200,000 for the completion of its sewerage system.

*Colfax, Wash.*—A system of sewerage is projected in connection with other public improvements.

**Streets.**—*Holyoke, Mass.*—The Highway Committee is considering the question of laying brick paving.

*Brooklyn, N. Y.*—The contract for constructing Surf Ave., at Coney Island, has been awarded to O'Rourke & Dady at about $257,000.

*Allegheny, Pa.*—Street improvement bonds for $75,000 at 4% are to be issued.

*Bedford City, Va.*—A vote on the issue of street improvement bonds for $25,000 will be held April 9.

*Roanoke, Va.*—The city will issue bonds of $420,000, $300,000 of which will be for new streets. Mr. Dunlap, City Engineer, is investigating street improvements in other cities.

*Big Stone Gap, Va.*—An ordinance has been passed authorizing the issue of bonds for streets and sewers.

*Fairmont, W. Va.*—It is proposed to issue bonds of $20,000 for firebrick paving.

*Huntington, W. Va.*—An ordinance has been passed authorizing the issue of $70,000 and $12,000 in bonds for streets and sewers, respectively. This will be the city's share of the expense, the balance being paid by property-owners.

*Covington, Ky.*—A proposition has been made by the John Porter Co., of Cumberland, Va., to lay a specimen brick pavement at $1.66 per sq. yd.

*Gallatin, Tenn.*—It is proposed to issue $10,000 in bonds for street work.

*Atlanta, Ga.*—The Council has passed ordinances providing for the expenditure of $17,000 in street paving.

*Montgomery, Ala.*—An issue of bonds for $50,000 for street work has been authorized.

*Cleveland, O.*—It is proposed to issue bonds for $300,000 for streets and sewers.

*Danville, Ill.*—Some streets are to be paved with Howell brick or brick blocks on 2 ins. of sand and 8 ins. of broken stone well rolled.

*La Grange, Ill.*—The La Grange Drainage & Pavement Co. has been organized by L. P. Richardson, D. W. Corr and O. L. Stratton; capital stock, $100,000.

*Kansas City, Mo.*—The city engineer is making tests of the strength, wearing capacity and absorption of different grades of paving brick.

*Little Rock, Ark.*—Vitrified brick paving is to be laid on Scott St. For particulars apply to Mr. R. A. Edgerton.

**Street Cleaning.**—At Buffalo, N. Y., the cost of street cleaning by the city is estimated by Mr. Quinn, the Street Commissioner, at $167,000 for the 10 months from March 1, or nearly $200,000 per annum. The former contractor received $102,000 per annum. The estimate includes street cleaning $117,586 and garbage removal $49,224. — The city of Louisville, Ky., has purchased 4 street sweepers, costing $450 each, from the Chapman-O'Neill Co., of New York N. Y.

**Street Signs.**—The Street Committee at Newark, N. J., proposes to put up from 5,000 to 15,000 signs, and is figuring on different styles. Enameled iron signs are said to cost 50 cts. each, signs of japanned sheet iron, letters on wood, $2.50 each; the old style of painted strips, 2 cts. a letter, and the old stencil signs in gas lamps, 20 to 25 cts. each.—The City Council of Buffalo, N. Y., has directed the City Engineer to readvertise for street signs.

## ELECTRICAL.

**Electric Light.**—New plants or extensions of those already existing are preported as probable in the following places: Elkin, N. C., address T. J. Lillard; Phœnix, Ala., address the East Alabama Improvement Co.; Morristown, Tenn.; Sumter, S. C.; Stanford, Ky., address J. S. Hughes; Aiken, S. C., address J. G. Gardner; Belmont, N. Y.; Watkins, N. Y.; Saltsburg, Pa.; Evanston, Ill., address the Evanston Electric Illuminating Co.; Wellington, O.; Brenham, Tex.; Wateree, S. C., address A. G. Clarkson; McConnellsville, O.; North Wilkesboro, N. C., address the Winston Land & Improvement Co.

*Erie, N. Y.*—It is reported that a company has offered to install a plant on a 10-year contract at $75 per year per light of 1,200 c. p. and at the end of the time to sell the plant to the city at cost.

*Newberry, S. C.*—Proposals are wanted by Mayor J. K. P. Goggan for the construction of water-works and an electric light plant.

*Austell, Ga.*—Mayor C. J. Shelverton will receive bids for the establishment of a lighting station.

*River Forest, Ill.*—The Maywood Co. has received a contract to furnish the village with 100 or more street lamps at $1 per month each.

*Waco, Tex.*—It is reported that the Waco Gas Co. has contracted with the city to furnish 50 arc lights of 2,000 c. p. capacity at the remarkably low rate of 90 cts. per month each.

*Portland, Ore.*—The city has advertised for bids on a two-year contract for furnishing 100 or more 2,000 c. p. arc, and 800 or more 25 c. p. incandescent lamps.

**New Companies.**—Collingswood Water & Light Co., Collingswood, Pa.; capital stock, $25,000. Wiley Electric Railway Signal Co., Bristol, Tenn.; President, W. B. Ainsworth; Secretary, J. A. Dickey. Domestic Heat, Light & Power Co.; capital stock, $10,000. Bergen & Bayonne Electric Co., Jersey City, N. J.; capital stock, $100,000; incorporators, P. Sury, C. E. Barrett, J. N. Bruns. Athol (Mass.) Gas & Electric Co.; capital stock, $25,000; President, G. C. Moses, of Bath, Me. Jermyn (Pa.) Electric Light, Heat & Power Co.; capital stock, $10,000; Secretary, W. S. Hutchings. Mexican Electric Co., Jersey City, N. J.; capital stock, $300,000; incorporators, I. Loveridge and S. Smithers, of New York; F. Giblin and G. Nordenholt, of Brooklyn; Adalberto Ybarra, of Mexico. Standard Light Co., Elizabeth, N. J.; capital stock, $20,000; incorporators, J. E. Browne, C. W. Noyes, H. J. Bauer and others. Electric Light & Power Co., Mayville, N. Y.; capital stock, $1,000; incorporators, L. B. and H. S. Bixby, W. H. Tennant. Eastern District Electric & Power Co., Brooklyn, N. Y.; capital stock, $300,000. Americus (Ga.) Illuminating & Power Co.; capital stock, $100,000; incorporators, H. R. Johnson, M. B. Harrold, W. E. Murphy. Gouyard Electric Co., Denver, Col.; capital stock, $100,000.

## CONTRACTING.

**Pipe and Castings.**—*Buffalo, N. Y.*—The following proposals have been received by the Water Commissioners Buffalo Cast Iron Pipe Co., $26.75 or $27.50 per ton for pipe

at foundry or delivered on the streets; $45 or $56 per ton for specials at foundry or delivered Warren Foundry & Machine Co, New York, N. Y, $26.90 per ton for pipe f. o b. cars at Buffalo. Lake Shore Foundry, Cleveland, O., $27 and $65 per ton for pipe and specials f. o. b. cars at Buffalo. Addyston Pipe Co., Cincinnati, O., $26.95 and $50 per ton for pipe and specials f. o. b. cars at Buffalo.

*Keene, N. H.*—The contract for furnishing pipe has been awarded to the Donaldson Iron Co., of Emaus, Pa., at $27.25 to $29.40 per ton for different sizes.

**Stone.**—*New York, N. Y.*—Contracts have been awarded as follows by the Department of Docks: J. A. Bouker, 88 and 63 cts. per cu. yd. for cobble and rip-rap stone; Brown & Fleming, 98 and 68 cts. per cu. yd. for same. Lt. Col. J. L. Gillespie, U. S. Engineer Office, has awarded the contract for furnishing large stone at Sandy Hook, N. J., to John Satterlee, of Englewood, N. J, at 79 cts. per gross ton.

*Boston, Mass.*—Proposals for paving blocks and curb stones have been received by the Park Commissioners as follows: Paving blocks: S. & R. J. Lombard, Charlestown, Mass., $44.90 per 1,000; Rockport Granite Co., Rockport, Mass., $52.90; Cape Ann Granite Co., $55; Pigeon Hill Granite Co., Rockport, Mass., $74. Curb stones: Cape Ann Granite Co., $1.49 per lin. ft.; H. E. Fletcher & Co., W. Chelmsford, Mass., $1.53; A. A. Libby & Co., $1.62; J. J. Vernon, Somerville, Mass., $1.62; Rockport Granite Co., $1.73; Pigeon Hill Granite Co., $1.79.

**Seawall.**—*San Francisco, Cal.*—The following proposals have been received by the Harbor Commissioners for the construction of section 8 of the seawall: The estimate of Mr. Manson, the engineer, was $111,250. The contract has been awarded to the San Francisco Bridge Co. The quantities include 1,476 piles and 770,000 ft. of lumber in timber foundation, 2 432 cu. yds. of concrete, 40,000 cu. yds. of sand, and 1,625 tons of stone.

| | Concrete. Per cu. yd. | Sand. Per cu. yd. | Stone. Per ton. | Timber foun'tion. | Total. |
|---|---|---|---|---|---|
| S. F. Bridge Co | $6.00 | $0.10 | $1.00 | $63,824 | $83,987 |
| Hoffman, Bates Co. | 12.60 | .30 | 1.50 | 42,000 | 85,513 |
| B. McMahon & Co. | 9.25 | .37½ | 1.75 | 46,450 | 86,706 |
| Darby, Laydon & Co. | 16.50 | .40 | 2.00 | 34,250 | 93,479 |
| Pacific Bridge Co | 10.00 | .30 | 1 00 | 57,140 | 94,995 |
| C. B. Doe | 15.60 | .30 | 1.25 | 45,460 | 97,290 |
| Randall Hunt | 16.50 | .32 | 1.00 | 45,205 | 99,610 |
| Healy, Tibbitts & Co. | 6.95 | .45 | 1.08 | 69,900 | 105,494 |
| Carter Bros | 7.00 | .09 | 1.10 | 84,535 | 106,878 |
| California Bridge Co. | 12.00 | .30 | 2.00 | 74,540 | 118,886 |
| W. C. Raisch | 17.00 | .50 | 2.00 | 70,000 | 134,441 |
| W. H. Norton | .... | .... | .... | 57,770 | 98,308 |

**Street Work**—*West Troy, N. Y.*—The Paving Commission has awarded a contract to Malone & McKenna, of Troy, N. Y., for granite block paving on a sand bed. Blocks 11 × 3¾ × 7½ ins., not less than 25 per sq. yd.; ¾ in. side joints, tight end joints. About 32,350 sq. yds. of pavement at $2.63; 11,916 sq. ft. of bridging, at 36 cts.; 16,680 lin. ft. of stone curbing at 67 cts.; resetting curb, 10 cts. per lin ft. The estimated cost was about $100,000. Mr. Marion Randolph is engineer in charge.

*Bradford, Pa.*—Contracts for brick and stove paving on gravel foundation have been awarded by F. W. Dalrymple, City Engineer, to Kelley & Sheehan: excavation, 33 and 36 cts. per cu. yd.; curb set, 46 cts. per lin. ft.; medina sandstone pavement, $2 per sq. yd.; brick pavement, $1.93 and $1.95 per sq. yd.; stone crosswalks, 27 cts. per sq. ft.

*Indianapolis, Ind.*—The following proposals for asphalt paving, etc, have been received from (A) the Western Paving & Supply Co. and (B) the Warren-Scharf Asphalt Paving Co., the prices being for lin. ft. on each side of the street:

| | A. | B. |
|---|---|---|
| Paving on Delaware St | $3.57 | $3.43 |
| " " | 6.22 | 6.29 |
| " Broadway St | 4.67 | 4.72 |
| " Wabash St | 3.11 | 3.15 |
| " Frost Alley | 2.33 | 2.36 |
| Repairing, per sq. yd. | 3.00 | 3.12 |
| Stone curbing, per lin. ft. | .60 | .59 |
| Round stone curbing, per lin. ft. | 1 20 | 1.18 |
| Round granite corners, per lin. ft. | 1.75 | 1 90 |
| Resetting curbing, per lin. ft. | .29 | .22 |

**Sewers.**—*Terre Haute, Ind.*—The contract for the Lafayette Ave. sewer has been awarded to Jesse Robertson; 12-in. pipe, 70 cts. per lin. ft.; manholes, $25 each; catch basins, $60 each.

*Bradford, Pa.*—A sewer contract has been awarded by F. W. Dalrymple, City Engineer, to James Carr at 25 cts. per cu. yd. for excavation, 13 cts. per lin. ft. for 8-in. sewer-pipe, 62 cts. each for 8-in. Y branches, $24 each for manholes.

**Dike.**—The lowest bid received by Lt. Col. J. W. Barlow, U. S. Engineer Office, Nashville, Tenn., for constructing a pile and stone dike at the mouth of the Tennessee River, Livingston Point, Ky., was from William Kirk, Madison, Ind., at $14,555. The prices are as follows: piles, $3 each: timber, $25 per 1,000 ft. B. M.; iron-work and spikes, 6 cts. per lb.; stone for dike and rip-rap, $1.25 per cu. yd.; brush, 80 cts. per cord.

**Piles.**—*New York, N. Y.*—The Department of Docks has awarded contracts as follows: Beard & Kempland, $6.75 each for piles 50 to 55 ft. long, $9.75 for 60 to 65 ft.; $15 and $20 each for piles 80 to 85 ft. long and 14 and 17 ins. diameter at the butt.

**Cement.**—*Detroit, Mich.*—The Board of Public Works has received bids as follows for furnishing cement during the current year: Noble & Co., 60 cts. per bbl.; H. R. Pierce, 70 cts.

## PROPOSALS OPEN.

**Street Work.**—*New York, N. Y.*—Granite block paving and asphalt paving on concrete. April 3.—Granite block paving on concrete, asphalt paving on macadam, concrete and present stone block. April 6. Department of Public Works, 31 Chambers St.

*Terre Haute, Ind.*—Road and sidewalk paving of cinders; wooden curb. A. C. Duddleston, City Clerk. April 7.

*Columbus, O.*—Asphalt and gravel paving, 6-in. stone curb. F. M. Senter, Clerk of Board of Public Works. April 1.

*Collinwood, O.*—G. H. Redfield, Village Clerk. April 6.

*Westwood O.*—Improving Beechwood Ave. Ernest Janes, Village Clerk. April 16.

*Williamsport, Pa.*—About 4,000 sq. yds. of brick paving. R. H. Faries, City Engineer. April 8.

**Sewerage.**—*Providence, R. I.*—Sewer pipe, 6 to 15 in. flagstones, invert blocks, catch-basin stones. R. E. Smith Commissioner of Public Works. April 2.

*Bath Beach, N. Y.*—Lateral sewers. The Sewer Commissioners. March 31.

*Marion, O.*—About 4,515 ft. of 15-in., 8,452 ft. of 8-in. and 640 ft. of 6-in.; manholes, subsoil drains, etc. The City Clerk. April 14.

**Bridges.**—*Cincinnati, O.*—Wrought-iron truss bridge; abutments and wing walls. The County Commissioners. April 25.

*Denver, Col.*—Bridge, piers and approaches at Champa St. The Board of Public Works. April 3.

**Dredging.**—*Philadelphia, Pa.*—Maj. G. W. Raymond, U. S. Engineer Office. April 9.

*Richmond, Va.*—In the James River. Col. Wm. P. Craighill, U. S. Engineer Office. April 1.

**Jetties.**—At Sabine Pass harbor, Tex. Maj. J. B. Quinn, U. S. Engineer Office. New Orleans, La. April 11.

**Steel Plates.**—*Washington, D. C.*—Steel plates and gun forgings. The Secretary of the Navy. April 15.

**Materials.**—*Buffalo, N. Y.*—Stone, Sand pebbles, cement and iron moorings. Maj. A. Stickney, U. S. Engineer Office. April 20.

**Levees.**—*New Orleans, La.*—New canal and Old canal levees. Commissioners of Orleans Levee District. April 3.

**Water-Works.**—*Dayton, Wash.*—Reservoir, well, aqueduct, pipe, gates, hydrant, etc. J. H. Day, Chairman of Water-Works Board. May 1.

**Macadamizing.**—*Wilmington, Del.*—About 6,000 ft. of grading, underdraining and macadam roadway. Wm. M. Canby, President of Park Commission. Extended to April 13.

## MANUFACTURING AND TECHNICAL.

**Locomotives.**—The Schenectady Locomotive Works, of Schenectady, N. Y., have shipped an engine to the Atchison, Topeka & Santa Fé. The Baldwin Locomotive Works, of Philadelphia, Pa., have built the 4 tank engines for the St. Clair Tunnel. They have an order for 8 consolidation engines, with cylinders 22 × 28 ins., and weighing 150,000 lbs., and 40 mogul engines for the Northern Pacific. Also for 3 freight engines for the West Virginia Central. The Manchester Locomotive Works, of Manchester, N. H., have delivered a ten-wheel engine to the Concord & Montreal. The Brooks Locomotive Works, of Dunkirk, N. Y., have delivered 6 engines for the New Mexico division of the Atchison, Topeka & Santa Fé. The Canadian Locomotive & Engine Works, of Kingston, Ont., are building 10 mogul engines for the Grand Trunk. The Canadian Pacific shops at Hodelaga have orders for 48 engines. The Long Island will add to its equipment 3 mogul passenger engines, 4 freight engines and 3 switch engines. Locomotives are wanted by D. W. Alderman & Co., Alcolu, S. C., and L. R. Benjamin, Jacksonville, Fla.

**Cars.**—The Barney & Smith Mfg. Co., of Dayton, O., has an order for 45 passenger cars, 5 dining-cars and a number of freight cars for the Northern Pacific; also 28 passenger cars for the Long Island. The Jackson & Sharp Co., of Wilmington, Del., is building 10 passenger cars for the Chicago & West Michigan. The Ohio Falls Car Co., of Jeffersonville, Ind., is building 500 freight cars for the Louisville Southern. The Buffalo Car Mfg. Co., of Buffalo, N Y., has an order for 200 gondola cars, with Trojan couplers, for the Mahoning Valley. The Long Island will add 20 passenger cars to its equipment. The National Tank Car Co., of Chicago, Ill., has been incorporated by W. G A. Hall, E. G. Wood and S. K. Pittman; capital stock, $50,000. A stock car company has been organized by a combination of the American Live Stock Transportation Co., Arms Palace Horse Car Co., Burton Stock Car Co., Canda Cattle Car Co., Hicks Stock Car Co., Keystone Palace Horse Car Co., Mather Horse & Stock Car Co., Montgomery Palace Stock Car Co., New England Car Co., and Street's Stable Car line. It is stated that works will be erected in Chicago. The Philadelphia & Reading is reported as intending to build extensive car shops at Reading, Pa.

**Rails.**—Light rails are wanted as follows: A. G. Wetmore, Superintendent Golden Valley Mining Co., Marion, N. C.; 3 miles of 20-lb. rails. D. W. Alderman & Co., Alcolu, S. C.; 4 miles of 25-lb. second-hand iron or steel rails. L. R. Benjamin, Jacksonville, Fla.; rails for 2½ miles of track. H. N. Snyder, Helena, Ark.; 4 miles of 15 to 20 lb. second-hand rails at Memphis, Tenn. W. A. Leary, 20 Vesey St., New York, N. Y., 11 miles of 56-lb. rails.

**Street Railway Track.**—R. T. White, of Boston and New York, has appointed the following agents for his Daisy and Eureka styles of track: W. D. Thomas, Savannah, Ga.; D. E. Garrison & Co., St. Louis, Mo.; Great Western Electric Supply Co., Chicago, Ill.

**Steel Ties.**—The Morrell Metallic Railway Tie Co., of Jersey City, N. J., and New York, N. Y., has been incorporated by R. Morrell, of Summit, N. J.; E. F. C. Young and J. D. Bedle, Jr., of Jersey City; C. Seidler, of Morristown, and L. S. Mott, of Newark. Capital stock, $250,000.

**Road Rollers.**—The city of Boston, Mass., has purchased a 15-ton Aveling & Porter steam road roller, being the fourth bought during the last 18 months.

**Poles.**—Milliken Bros., of New York, report a large demand for their patent poles for electric railways and electric light, and among recent orders is one from Pittsfield, Mass., where the streets are said to be unusually wide, causing a heavy strain on the poles. They have completed large shops with special machinery for this class of work.

**Bridge Work.**—M. Riney & Co., Chicago, Ill., are erecting a plate-girder bridge over the Chicago River for the King Iron Bridge & Mfg. Co., of Cleveland, O. It has 2 spans of 66 ft., 1 of 45 ft., and 1 of 80 ft. They are also erecting for the Mt. Vernon Bridge Co., of Mt. Vernon, O., 19 spans, varying from 68 to 149 ft., on the Pittsburg, Fort Wayne & Chicago.

**Plumbago.**—The Dixon Crucible Co., of Jersey City, N. J., states that it has given considerable attention to the use of plumbago facings for sand molds for aluminum castings.

**The Curtis Regulator Co.**, of Boston, Mass., reports a good business in pressure regulators.

**The Tuerk Hydraulic Power Co.**, of New York, has removed from 12 Cortlandt St. to 237 Broadway.

**Companies.**—Marsh Elevator Co., of Jersey City, N. J.; incorporators, D. S. Steele, East Orange, N. J.; Chas. A. Marsh, New York, N. Y.; capital stock, $50,000. Curry Signal Co., of Danville, Va.; to manufacture automatic railway signals; incorporators, G. W. Welsh, A. M. King and T. P. Curry; capital stock, $100,000. United States Railway Equipment & Construction Co., of Chicago, Ill.; incorporators, Wm. Armstong, F. B. Dycle and Lawrence Harmon. Standard Equipment Co., of Jersey City, N. J.; to manufacture railway supplies; capital stock, $100,000. National Brass & Iron Co., of Reading, Pa.; capital stock, $30,000. Railway Electric & Auto-Pneumatic Signal Co., of Rochester, N. Y.; President, James H. McCartney, Rochester, N. Y. Monongahela Mfg. Co., of Monongahela City, Pa.; incorporators, W. H. Morrison, T. H. Pollock James Neel; capital stock, $50,000.

**Metal Market Prices.**—*Rails.*—New York: $30 75 to $31; old rails, $21 to $21.50 for iron and $17.25 for steel. Pittsburg: $26.50 to $27; old rails, $24 to $25 for iron and $17.75 to $18 for steel. Chicago: $31; old rails, $23 to $23.25 for iron and $15 to $17.50 for steel.

*Foundry Pig Iron.*—New York: $14 to $16. Pittsburg: $15 to $17. Chicago: $14.50 to $16.

*Track Materials.*—New York: steel angle bars, 1.7 to 1.8 cts.; spikes, $1.9 to $1.95; track bolts, 2.65 to 2.75 cts. with square, and 3.1 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.9 to 1.95 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.85 to 2.95 cts. with hexagon nuts.

*Pipe.*—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

*Lead.*—New York, 4.35 to 4.45 cts. Chicago, 4 15 cts. St. Louis, 4.1 cts.

*Structural Material.*—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2 7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 to 2.1 cts.; tees, 2.85 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 to 2.35 cts.; refined bars, 1.9 cts.; steel plates, 2.2 to 2.25 cts. for tank, 2.55 to 2.6 cts. for shell, 2.75 to 2.85 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.65 to 2.75 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.